POWER

Volume 66 New York, December 20, 1927 *Number 25*

Merry Christmas

Once more the earth has traced its course around the sun and once again on behalf of those who have to do with the making of Power I extend to all to whom these presents may come, our cordial wishes for a full measure of Christmas Cheer.

A curious cargo this old world carries over that orbit year after year.

Physically, its freight remains unchanged, but what of its personnel?

Are its inhabitants gaining wisdom with the passing years?

They are increasing their knowledge of the constitution and resources of the whirling globe upon which they live. They have subdued its forces and adapted its materials to their uses and abated the perils and rigors of their environment until they have arrived at a condition where mankind's worst enemy is man himself.

What would it mean, just in material well-being, to say nothing of psychical development, if the precepts announced twenty centuries ago by the Great Reformer whose birth we celebrate were universally practiced?

No war or fear of war; no crime or deprivation or oppression. His Kingdom on Earth.

And the making of it in our hands.

F. R. Low

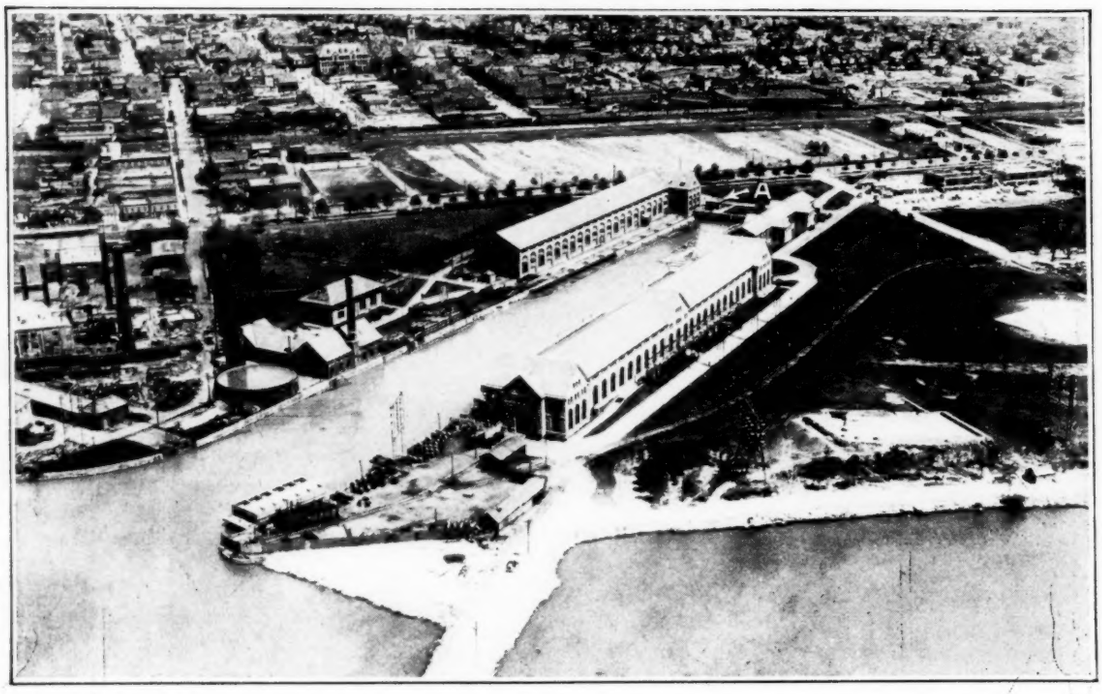


Fig. 1—Airplane view of Niagara generating station and vicinity

The Niagara Falls Power Company

Improves Its Niagara Plant*

By E. B. STROWGER

Engineer of Hydraulics,
The Niagara Falls Power Company

By redesigning parts of the old waterwheels and rebuilding the generators a seven per cent gain in efficiency was obtained

THE story of the recent steps taken in modernizing the Niagara hydro-electric generating station of The Niagara Falls Power Company is noteworthy because valuable results were obtained by designing and adapting new equipment for an old plant, and because of proving the results by testing the plant to obtain its operating characteristics.

Fig. 1 gives an airplane view of the plant as it appears today. Power house No. 2 is in the foreground and Power house No. 1 in the background of the picture, one station on either side of the canal inlet. Fig. 3 is a typical cross-section of the plants.

The development is of the tailrace tunnel type with the generating stations near the point of diversion from the upper Niagara and with a long, deep and relatively narrow slot cut into the rock forming the wheelpit. Vertical penstocks pass down the wheelpits and connect the canal inlet or forebay with the wheels at the lower level. From the turbines the water is discharged into the bottom of the wheelpit, and thence through a tailrace tunnel 21 ft. in diameter and 7,500 ft. long it is returned to the Niagara River in the Maid-of-the-Mist pool.

It was during the early period of hydro-electric development that these two power houses were built. On Oct. 4, 1890, ground was broken at Niagara Falls for the initial power installation of Niagara generating station No. 1. The first power from this, at that time, enormous trial development of 15,000 hp. was delivered commercially five years later. On Feb. 12, 1900, ground was broken for the tunnel extension to station No. 2, the latter being finished in 1904.

In 1918 The Niagara Falls Power Company was consolidated with the Hydraulic Power Company, which had begun its operations in 1877, the control of the former passing into the hands of the latter, although the new company was called The Niagara Falls Power Company. At that time the two power houses, Nos. 1 and 2 (which then became known as the Niagara Plant), contained a total of 21 hydro-electric units each rated at 5,500 hp.,

* This article was one of the forty-four submitted in *Power's* Prize Contest, and it received favorable mention from the judges.

making a total installed capacity of 115,500 hp. Current was generated at 2,200 volts two-phase, transformed to either 22,000 volts three-phase or 11,000 volts three phase, or distributed at 2,200 volts two-phase.

Although the plant had been built by the best talent of its day and had been improved from time to time, yet after the consolidation, previously referred to, the engineers of the company, after making a comprehensive study of the plant, found that numerous improvements could yet be made. It is these improvements, made from about 1921 to date, with which this paper is concerned, and which will be described in some detail. The major changes, many of which have been completed during the last two years, are as follows:

1. Hydraulic and Mechanical Changes:
   (a) Installation of Gibbs thrust bearings.
   (b) Elimination of turbine balance pistons.
   (c) Stopping of auxiliary use of water.
   (d) Installation of rubber seal rings on unit No. 21.
2. Electrical Changes:
   (a) Rewinding of five 2,200-volt two-phase generators to three-phase 12,000 volts.
   (b) Switching improvements and installation of remote-control switching apparatus with centralized control.
   (c) Installation of motor-generator exciters to replace turbine exciters.
   (d) Relay protection and automatic control of elevators.
3. Testing the plant by the Gibson method to determine operating characteristics and effect of improvements in plant efficiency.

Installation of New Thrust Bearings

In station No. 1 the thrust bearings were high-pressure oil bearings of the roller type designed by C. C. Egbert. With these bearings, if the oil pump failed, satisfactory operation for only about twenty minutes could be expected with the supply of oil held within the bearing seals.

In station No. 2 the thrust bearings were disk bearings operated with an oil pressure of 250 lb. per sq.in. The oil pressure held the disks apart, and if the pump failed while the unit was running or if the bearing disks were in contact when starting, seizure was likely to take place. Bearing failures were consequently quite common with this type of bearing. As a solution to the problem Gibbs bearings operating in an oil bath were substituted for the older type.

Temperature indicators were installed on the bearings giving an indication on the main floor. This and the elimination of the eleven high-pressure oil pumps on the thrust deck eliminated the work of three men as thrust-deck attendants.

The design of the new bearings was adapted to the existing housing and shaft arrangements. The total pressure on one bearing is about 150,000 lb. exclusive of the hydraulic thrust, and the working bearing pressure used was 375 lb. per sq.in., giving a net bearing area of 415 sq.in. when allowance was made for the hydraulic

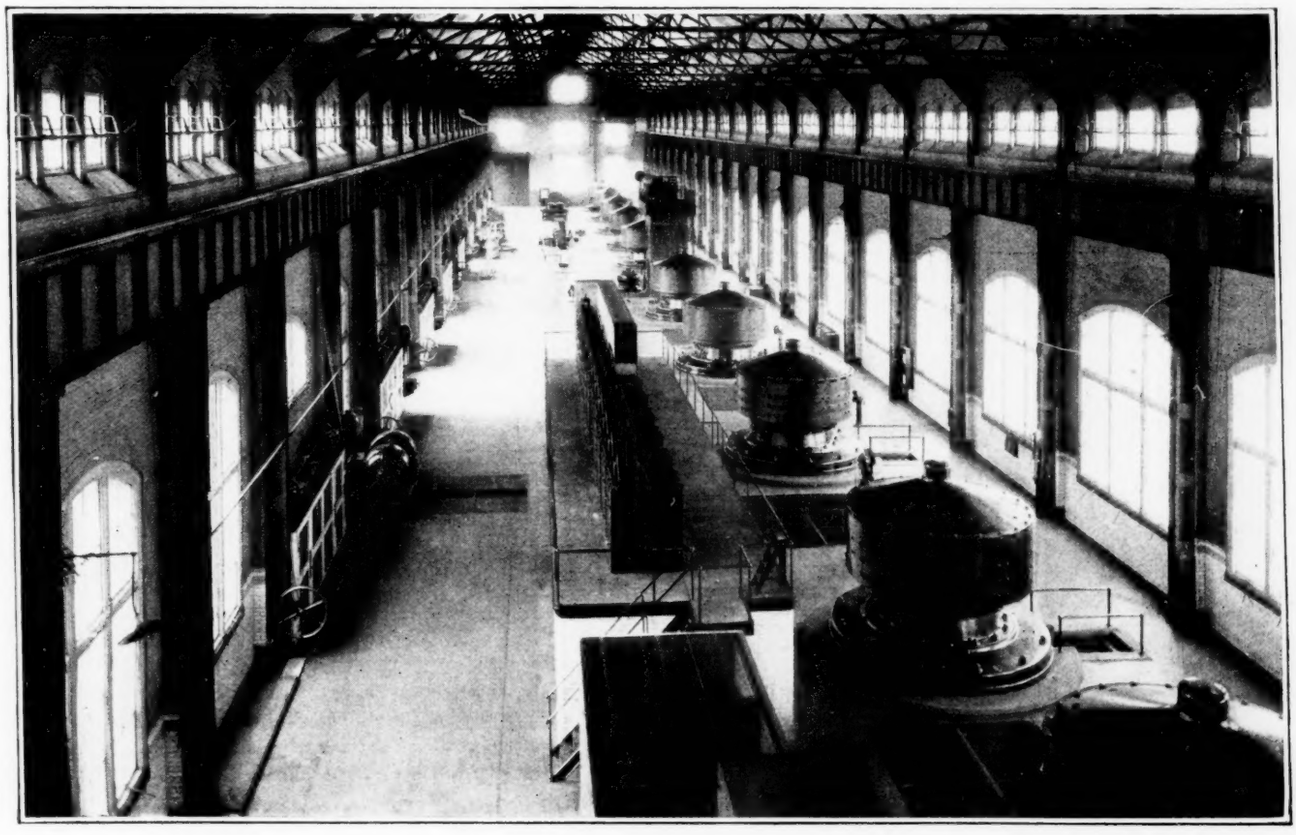


Fig 2—Interior view of station No. 1, showing 10 umbrella-type generators

thrust. This specification allowed the use of the old bearing parts and also allowed room for copper cooling coils in the oil supply within the housing. The general arrangement of one of the new bearings is shown in Fig. 4.

Elimination of Turbine Balance Pistons

The units in generating station No. 2 were equipped with balancing pistons below the turbine, as shown in Fig. 5. The thrust bearings were capable of taking the entire thrust, but it was originally intended to counterbalance most of the weight of the revolving mass by hydrostatic pressure acting on the lower surface of a disk secured to the shaft. The turbine shaft extended through the wheel to the balancing piston, below which water pressure was supplied. The revolving piston caused considerable loss due to disk friction. Furthermore, the necessary running clearances between the pistons and cylinder, becoming larger as wear took place, caused a considerable auxiliary use of water for the eleven machines in Station No. 2.

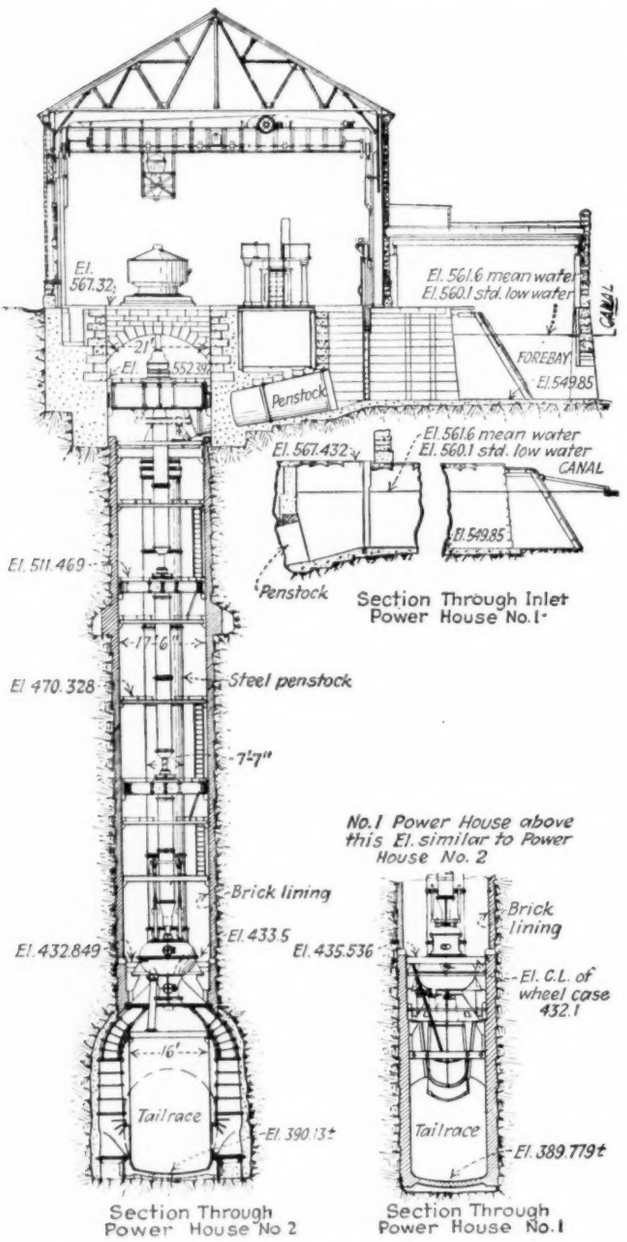


Fig. 3—Typical cross section of stations Nos. 1 and 2

For these reasons each Gibbs bearing that had been installed in this station was made to take the entire load and the shaft was cut off below the runner at *A*, as shown in the figure, allowing the removal of the piston and lower turbine bearing.

It is estimated that with the same use of water an increase of about 2 per cent of the rated load of the machines was made by eliminating the balancing pistons.

Stopping of Auxiliary Use of Water

Motor-generator exciters were installed to replace the turbine-driven exciter plants, and the Pelton-wheel driven air compressor was superseded by a motor-driven unit. These changes, together with the elimination of the balancing pistons, decreased the auxiliary use of water to a large extent.

An ice shaft for the plant is located at *A* in Fig. 1, at the downstream end of power house No. 1. The ice run gate is detailed in Figs. 6 and 8, which show the new design of rubber seal. With this design and with the special rubber used, practically all the leakage through the ice chute was eliminated and the seals so far have proved to be more durable. The special rubber used is a product of the United States Rubber Company designated by D-4-15 and is a result of special research into the application of rubber to this and similar problems.

Rubber Seal Rings on Turbine No. 21

The plant gradually changed from the status of one constantly supplying power to one for intermittent service, or in other words it became a stand-by plant, owing to the construction of the new 3-C hydraulic station. Therefore, the leakage water through the old plant became of great importance. In the event of an interruption at one of the other stations the units at the Niagara station were to be immediately available and yet while not in use there should be a minimum use of water due to leakage because this water is considered as part of the company's allowable diversion.

In operating the plant as a stand-by, the headgates are all closed tight except on five or six units which are kept with full operating pressure in the wheel case. The cylinder gates or "ring valves" on the turbines seated tight, but there was a small amount of leakage past the upper gate seal into the space below the head-cover and thence to the draft tube.

As an experiment in entirely stopping this small leakage, one unit in station No. 2 was fitted with rubber seals on the ring valve guide. A strip of rubber as shown in Fig. 7 was set in the valve guide. This pressed against the ring valve, leaving the valve free to move, yet fitting so close that all leakage to the head cover was practically stopped irrespective of the position assumed by the ring valve. With the valve closed and with full operating pressure in the wheel case, an inspection below the runner showed no noticeable leakage.

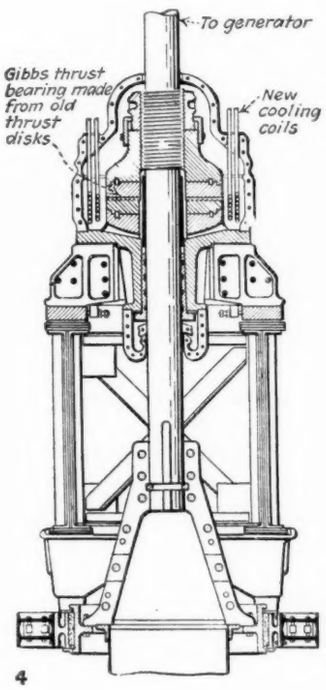
Rewinding Five Generators

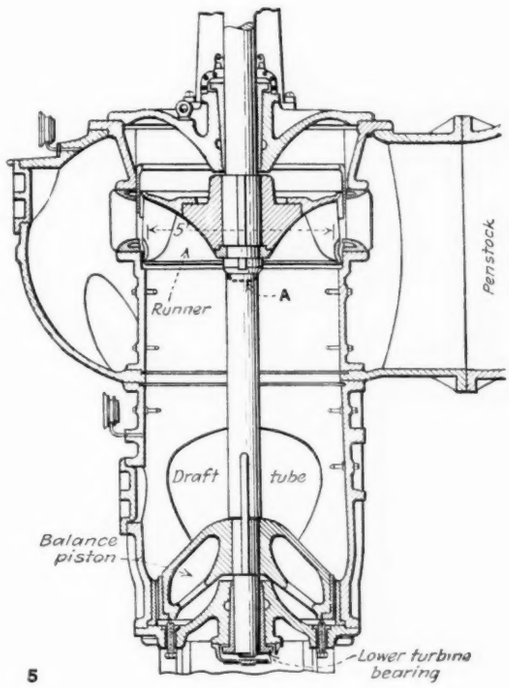
The ten generators in station No. 1 were of the "umbrella" type with an external revolving field. In

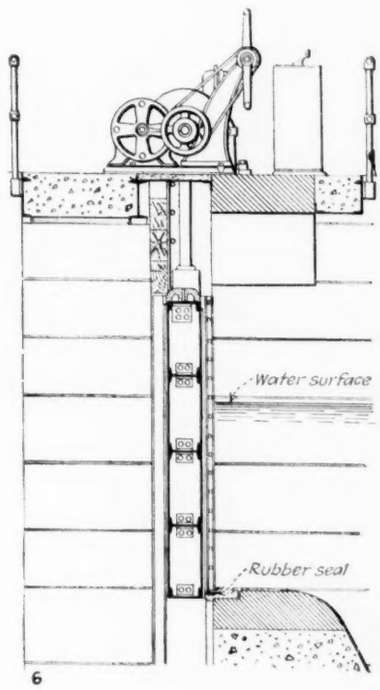
station No. 2 the first six generators are similar in design, the other five having internal revolving fields, and all were designed for 2,200 volts two-phase.

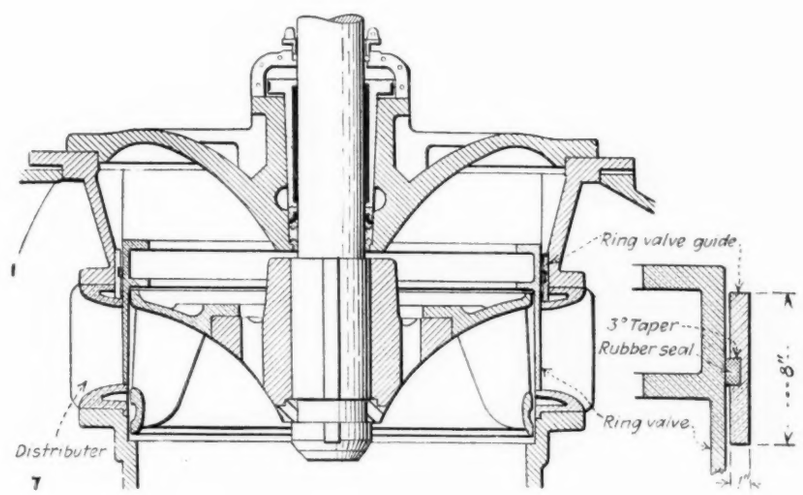
The first five of the generators in station No. 1, shown in Fig. 2, were rewound for 12,000 volts three-phase. New armature iron replaced the old laminations with open slots substituted for the closed slots and with new coils and insulation.

Efficiency tests, by the retardation method, were made on the generators before and after the overhauling and rewinding, by J. A. Johnson, electrical engineer of The Niagara Falls Power Company. This method was described in a paper, "The Retardation Method of Loss Determination as Applied to the Large Niagara Generators," *A.I.E.E. Journal*, Vol. XLV, June, 1926, page 546. The segregated losses and efficiencies at the rated









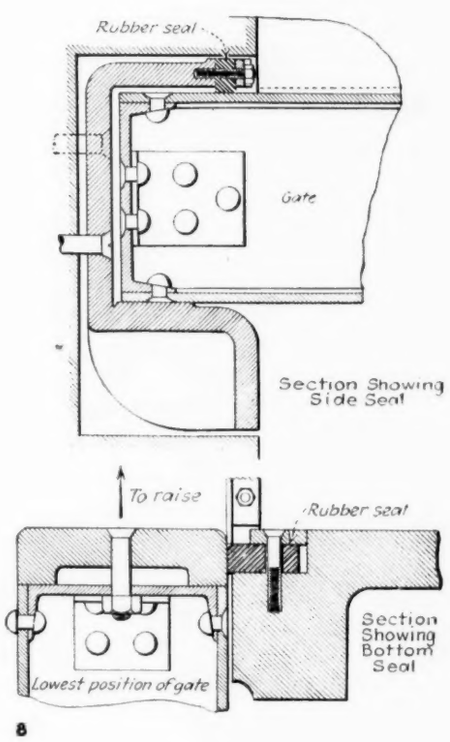


Fig. 4—New thrust-bearing arrangement

Fig. 5—Turbine with balance piston and lower guide bearing

Fig. 6—Section through ice run gate

Fig. 7—Rubber seal ring in turbine No. 21

Fig. 8—Rubber seal details for ice-run gate

load before and after rebuilding are indicated in the table, and a comparison of the efficiency curves is given in Fig. 9.

LOSSES IN KILOWATTS AT 3,750-KW. LOAD AND 90 PER CENT POWER FACTOR

Voltage	Iron Loss	Friction and Windage	Load Loss	Arm. I^2R	Field I^2R	Total Loss	Per Cent Loss	Per Cent Eff.
2,200.....	41.2	42.6	210.0	34.9	15.8	344.5	8.42	91.58
12,000....	32.5	47.5	17.4	38.6	11.8	147.8	3.79	96.21
Difference.	+8.7	—4.9	+192.6	—3.7	+4.0	+196.7	+4.63	4.63

From the table it may be seen that the iron loss was reduced by about 20 per cent, the load losses were reduced by about 90 per cent, and the field I^2R loss by about 25 per cent. The friction and windage loss increased slightly owing to the elimination of the covers at the lower end of the stator spider for purposes of ventilation, and the armature I^2R loss also increased somewhat.

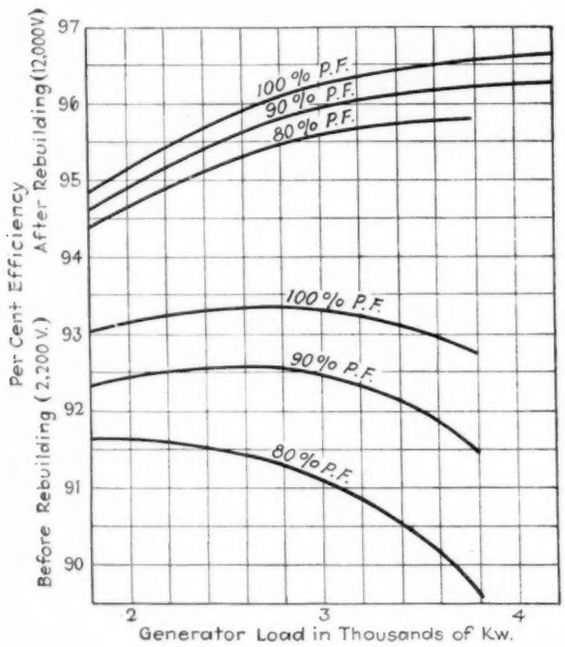


Fig. 9—Efficiency tests of generator No. 1 before and after rebuilding

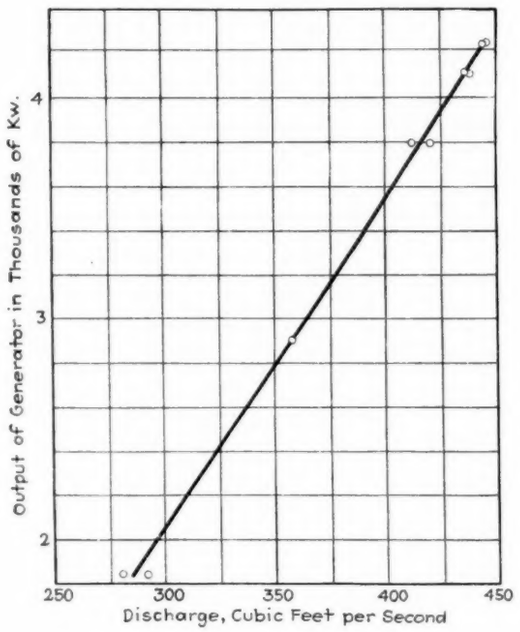


Fig. 10—Power-discharge relation for unit No. 4, established by Gibson test

The total losses, however, were reduced by about 57 per cent, of which the most important reduction was in the load loss, which was decreased from 210 kw. to 17.4 kw. by practically eliminating the eddy currents in the armature copper. This was made possible by the reduced section of copper for the higher voltage, the subdivision of the conductor into smaller strands and to the modern type of winding.

The total losses at 3,750 kw. 90 per cent power factor amount to 147.8 kw., which is considerably less than half the losses before rebuilding. This resulted in increasing the generator efficiency from about 91.58 per cent to 96.21 per cent, a gain of 4.63 per cent

Before rebuilding it was not possible to operate these generators continuously above 3,000 kw. 90 per cent power factor without excessive heating. On account of the lower temperature resulting from the higher efficiency it is possible since rebuilding to operate the machine continuously at full turbine output of approximately 4,500 kw. at 90 per cent power factor without exceeding safe operating temperatures.

A transformer station inside the plant was superseded by an outside station shown. The old air-blast transformers were replaced by modern equipment. The two switchboards in station No. 1 with pneumatic control and with open-air knife-blade switches were replaced by an electric centralized remote control with automatic oil switches.

The installation of modern oil switches together with modern relays afforded better protection, did away with a fire hazard and gave the operators more assurance as to safety of operation.

Since the motor-generator sets installed for the new system of excitation eliminated the ice hazard occurring in the winter time when operating the small waterwheel-driven exciter units, a better factor of continuity of operation was obtained. Furthermore, the motor-generator sets on the main floor were to be under the supervision of the main switchboard operator instead of the special exciter tender in the wheelpit, which made it possible to dispense with the services of three exciter tenders.

CO relays were installed in the rear of the switchboard in station No. 2 for generator protection, and they were also installed for feeder protection.

One elevator in each power house was made automatic, releasing two men for other duties.

Test Made on Rebuilt Units

The government authorized curves for reporting water diversion to the plant were no longer correct owing to the extensive improvements made. Accordingly, the company made application to the Niagara Control Board for permission to make new rating tests for the purpose of revising the authorized curves. These curves were relations between power output in kilowatts and water

diversion in cubic feet per second, from which water quantities may be determined from the known values of plant output. The new rating tests were made by the Gibson method. This method was described in a paper, "The Gibson Method and Apparatus for Measuring the Flow of Water in Closed Conduits," by N. R. Gibson, *Trans. A.S.M.E.*, Vol. 45.

The differential application of the method was used with a section of penstock about 85 ft. long. The quantities measured varied from about 250 to 450 cu.ft.-sec., or from about 35 per cent gate opening to full gate.

At small values of gate opening there was a tendency for the cylinder gate or ring valve to be a trifle unsteady owing to the sudden expansion of the water column as it entered the runner and to the small size of governor oil piping, which introduced a time lag in the governor oil system. To obviate this difficulty, a special hand control device was installed on the governor of the machine under test. The use of this device made it unnecessary to install larger governor piping for testing purposes and resulted in consistent repeated measurements of part gate discharges as well as those at full gate where the gate is blocked. A typical power discharge curve for the machines is shown in Fig. 10. The most efficient use of water with the cylinder-gate machine occurs at full gate. The operating policy adopted for the plant is, therefore, made as follows:

When it is necessary to load this plant, such a load is taken that no machine is operated at part gate, this being possible as the plant is connected with the other plants of the system where small increments of load are taken and where the regulating is done. When the unit is needed, the chief operator receives word from the system-load dispatcher, and in a few minutes from one to five units can be delivering full load. In case the load dispatcher is able to anticipate the need of one or more units, the number to be used are run at speed-no-load until the governor opens the gates automatically.

Summary of the Change Made

The hydraulic capacity of the plant in 1921 was limited to the discharge from twenty machines. Since the improvements were made as described, 21 machines can be run simultaneously at full load without taxing the discharging capacity of the wheelpits and tunnel. The capacity of the plant has thus been increased about 5,000 kilowatts.

By comparing the results from the new tests with the relations between power and discharge in former use, some idea of the gain in efficiency of the plant as a whole can be obtained. For the generation of 100,000 hp. the former curves gave a discharge of 8,610 sec.-ft., while the recent tests give a discharge of 7,983 sec.-ft., indicating a gain of about 7 per cent improvement in plant efficiency for an output of 100,000 hp. This is exclusive of the considerable gain made beyond the oil switches such as the elimination of the old air-blast transformers.

These gains in plant efficiency permitting a better use of water for the plant, either continuously or as a standby, together with the gains in operating efficiency which contributed to the safety and convenience of the operator and to continuity of service, are making every cubic foot of water do its maximum amount of work to meet the rapidly increasing demands for power.

What Do You Know?

By L. H. Morrison

The answers are on page 972

IN THE play "Lightnin'" the character Jones, to show his importance, points out that even though his pension check bore the signature of the Secretary of War and of the Treasury, it was absolutely no good without the signature of Bill Jones. A lot of engineers become of importance only when signing the pay check because they do not know the underlying principles of engineering; at all other times they are but workmen. Are you one of these signature men of importance? Or do you know your stuff so that the management consults you on its engineering problem? How much do you really know? Can you answer these ten questions?

Ques. 1—What is the average temperature of the air in the crankcase of a crankcase scavenging oil engine?

Ques. 2—Is a smoky chimney indicative of a decided loss in boiler efficiency?

Ques. 3—Why does the firebrick lining give more trouble in case of a water-tube than in case of a fire-tube boiler?

Ques. 4—A centrifugal pump will not deliver water at a given head if its speed falls below that required to develop this pressure head. In a motor-driven boiler feed pump the frequency of the plant auxiliary power may drop so that the motor speed will fall below the speed necessary to deliver water against the boiler pressure. How is this trouble avoided in modern plants?

Ques. 5—In a vertical shell-and-tube condenser in a refrigerating plant, how much does the velocity of the water dropping down through the tubes vary from one-half to full load?

Ques. 6—Name two methods of regulation used in the control of the feed water going to a boiler.

Ques. 7—How are sectional headers for water-tube boilers made?

Ques. 8—How many hours would you expect a 1,000-kw. turbine to run on a gallon of lubricating oil?

Ques. 9—What advantage has a single-pipe steam heating system over a double-pipe system?

Ques. 10—What is the difference between a lap and a wave armature winding?

Combustion Control Formulas

II—The Pound Carbon Fuel Unit

By E. A. Uehling

M. E., Dr. of Engineering

COAL consists of two distinct parts: Coal substance, the so-called combustible and impurities. The former is composed of carbon, oxygen, hydrogen and nitrogen. The latter consists of moisture, earthy matter (ash) and sulphur. Although sulphur is a combustible, its heating value in the pure state is only 4,000 B.t.u., but it does not exist in its pure state in the coal and its harmful effects more than neutralize its heating value. The carbon is all available for combustion, but the hydrogen is partly combined with the oxygen and exists in the form of water of hydration, and therefore a weight of hydrogen equal to one-eighth the weight of the oxygen is unavailable for combustion. Thus if H_t represents the total hydrogen and H_a the part that is available for combustion, then $H_a = H_t - \frac{O_2}{8}$. Now if H_t and H_a are divided respectively, by the percentage of carbon in the coal, then $\frac{H_t}{C}$ = weight of total hydrogen per pound of carbon and $\frac{H_a}{C}$ = weight of available hydrogen per pound of carbon. Proceeding in this manner with all the constituents of any given coal, we have $1 + \frac{H_t + O + N + S + Moisture + Ash}{C} =$ weight of coal containing one pound of carbon,[1] which will be called the pound carbon fuel unit.

THE pound carbon fuel unit is that weight of fuel containing one pound of carbon, and is shown in this article to be nearly equicalorific for each of several types of fuel.

The heating value of one pound of carbon is 14,600 B.t.u. and that of hydrogen is 62,000 B.t.u. The heating value per pound carbon unit is therefore $14{,}600 + 62{,}000 \times \frac{H_a}{C}$ B.t.u.

Coals have been divided into five classes according to their probable geological ages, viz.: Anthracite, semi-bituminous, bituminous, sub-bituminous and lignite. The proximate and ultimate analyses of representative samples taken direct from the seams of the principal mines in all the coal producing states have been reviewed and the heating value of the coals per pound of coal, per pound of combustible and per pound carbon unit tabulated. The relation of these heating values to each other and to the percentage of oxygen in the fuel is clearly shown by the curves in the accompanying figure.

[1] The same result may be more easily obtained by dividing 1.00 by the weight of carbon in one pound of coal.—Editor.

The heating value of the pound of coal is irregular, and becomes more so as the percentage of oxygen increases and the trend is more and more rapidly downward. The heating value of the pound of combustible is remarkably constant up to 4 per cent of oxygen; from this point it becomes more and more irregular with a marked downward trend.

The heating value of the pound carbon unit is less regular than the pound of combustible up to 3 per cent of oxygen, after which it becomes more regular than the latter. The trend is gradually upward to 6 per cent of oxygen content, after which the trend is very gradually downward. The greatest variation from the average heating value, as is apparent from the graph, occurs in the semi-bituminous class, and is 2.90 per cent. The other classes show less than 2 per cent maximum variation from the average.

Fuel oil and natural gas vary more from the average than the solid fuels owing to the variation in the amount of gasoline and other light oils abstracted from the raw oil, and it may be advisable where accuracy is important to determine the true heating value of the pound carbon unit of the oil used. This is readily done if a correct ultimate analysis of the oil as fired is available. The average or standard heating values (H_s) of the pound carbon fuel unit for six kinds of natural fuels are given in Table I.

TABLE I—HEATING VALUE OF THE POUND CARBON FUEL UNIT

Anthracite coal	Hs = 16,400 B.t.u.
Semi-bituminous coal	Hs = 17,600 B.t.u.
Bituminous coal	Hs = 17,900 B.t.u.
Sub-bituminous coal	Hs = 17,500 B.t.u.
Fuel oil	Hs = 23,600 B.t.u.
Natural gas	Hs = 34,000 B.t.u.

As independent samples taken from the same coal pile frequently vary 5 per cent and over, the standard heating value is therefore more reliable than the heating values determined from sampling of the coal.

In support of this last statement are presented in Tables II and III the coal analyses data of the most celebrated series of boiler tests known to the author, which were carried out under the direct supervision of Dr. D. S. Jacobus for the Detroit Edison Company to test the capacity and efficiency of the large boilers then newly installed at their plant. These tests, 22 in number and from 24 to 109 hours' duration, were carried out in the most scientific manner. Every precaution was taken to guard against error in observing and recording the data and in calculating the results. The data and results

of these tests were quite fully reported in a paper presented to the A.S.M.E. by Dr. D. S. Jacobus, in which he says: "The preliminary and regular tests required that the boiler room of a large power house be under control of the observers for nearly three months and for over six weeks over 50 men worked in eight-hour shifts night and day exclusively on the tests." Doctor Jacobus says further: "The Solvay Process Company made heat determinations and the analysis of the coal. Duplicate samples were taken and the work was done a second time in the laboratory of the Babcock & Wilcox Company. The average of the results secured by the two laboratories were used in working up the results."

Table II gives the proximate analyses of the duplicate samples, the heating values and also the difference in B.t.u. and in per cent. The percentages are based on the

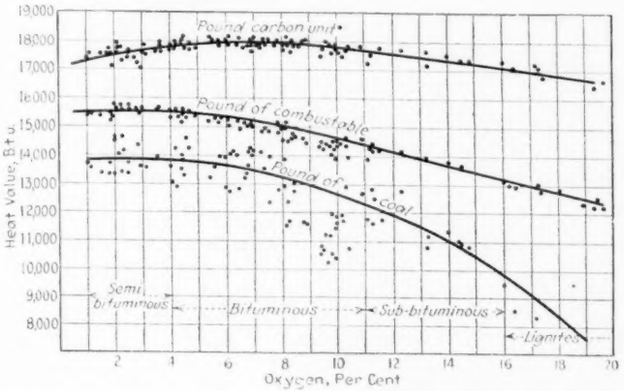
TABLE II—PROXIMATE ANALYSIS OF DUPLICATE SAMPLES

No. of Test	Sample	Fixed Carbon	Volatile Matter	Moisture	Ash	B.t.u.	Variation — B.t.u.	Variation — Per Cent
1	S	59.50	35.24	1.82	5.26	14,369	15	0.11
	B	63.69	31.15	2.17	5.16	14,354		
2	S	59.44	34.08	1.30	6.48	14,225	1	0.00
	B	63.55	30.31	2.36	6.14	14,224		
3	S	59.31	34.95	1.58	5.74	14,400	185	1.30
	B	61.01	32.78	1.83	6.21	14,215		
4	S	58.01	33.98	1.94	8.01	14,529	455	4.03
	B	62.89	31.13	1.66	5.98	14,984		
5	S	58.56	34.83	1.52	6.61	13,747	298	2.17
	B	62.73	32.23	2.08	5.04	14,045		
6	S	60.02	33.40	2.35	6.58	13,572	929	6.11
	B	62.17	33.27	2.09	4.60	14,501		
16	S	63.57	27.81	2.78	8.62	14,155	642	4.52
	B	66.94	27.84	2.47	5.22	14,797		
17	S	63.29	28.67	2.28	7.95	14,265	456	3.20
	B	66.49	27.70	2.62	5.81	14,721		
18	S	57.36	31.63	2.06	11.01	13,385	608	4.54
	B	62.30	29.75	2.28	7.95	13,993		
7	S	60.27	34.88	1.70	4.85	14,240	481	3.38
	B	62.09	31.35	2.13	6.56	13,759		
8	S	59.63	33.76	1.78	6.61	14,009	89	0.64
	B	63.64	31.15	2.04	5.21	13,920		
9	S	58.34	33.29	2.12	8.37	13,769	459	4.06
	B	61.25	32.63	2.13	6.12	14,228		
10	S	58.98	34.17	1.92	6.85	13,876	624	4.50
	B	60.26	33.97	2.20	5.77	14,500		
11	S	58.80	34.49	1.70	6.71	13,889	343	2.47
	B	62.36	32.47	2.10	5.17	14,232		
12	S	58.82	33.56	1.83	7.62	13,790	440	3.19
	B	62.86	31.84	2.06	5.30	14,230		
14	S	59.82	34.34	2.00	5.84	14,111	322	2.28
	B	63.24	32.09	1.80	4.67	14,433		
	Average						340	2.97

Solvay Process Company's (S) samples. The comparison shows that the variation in heating value between duplicate samples ranges from 1 to 929 B.t.u. or from 0 to 6.11 per cent, an average of nearly 3 per cent. Table II demonstrates the difficulty involved in securing a true average sample from a large quantity of coal, even when the greatest care is exercised.

Table III gives the analyses of the coal substance (ash and moisture free coal) of the average of the duplicate samples, and the heating values of the pound carbon unit; also the variations of these heating values from the standard $H_s = 17{,}900$ B.t.u. From this table we see that the actual heating value of the pound carbon unit determined from the average analyses of the duplicate samples, varies from 0.39 to 2.80 per cent from the standard heating value of the coal. An average variation of 1.57 per cent against the 2.97 per cent variation between the duplicate samples.

The importance of this series of boiler tests, the elaborate preparations made in carrying them through and the high grade of personnel employed, leave no room for doubt that the duplicate samples were taken and analyzed and the heating values determined with the greatest care. Yet, notwithstanding all this, the average difference in heating value between duplicate samples was 2.97 per cent and that this difference varied from 0 to over 6 per cent demonstrates the difficulty of getting a true average sample from any large quantity of coal. On the other hand, the fact that the difference between the heating values of the pound carbon unit determined from the average analysis of the duplicate samples and the standard heating value of the coal, 17,900 B.t.u. derived from a large number of analyses of samples taken from all the important bituminous coal fields averages only 1.57 per cent and that the maximum difference is 2.80 per cent should go a long ways toward demonstrating that 17,900 B.t.u. is a more reliable heating value



Relation between percentage of oxygen and the heating value of various fuel units

than can be expected from the determination of the heating value from samplings of the coal.

It is not claimed that 17,900 B.t.u. is the scientifically correct heating value of the pound carbon unit of all bituminous coal. It is the *practically* correct value and it is *more nearly* the correct heating value than can be determined with the means at the command of the engineer of the average power plant.

The great advantage of the pound carbon fuel unit over the pound fuel unit is: First, it is practically equicalorific

TABLE III—ULTIMATE ANALYSIS AVERAGE OF DUPLICATE SAMPLES

No. of Test	C	H	O	N	B.t.u. per P.C. Unit	Variation from Standard B.t.u.	Variation from Standard Per Cent
1	79.51	5.69	7.39	1.08	18,320	420	2.35
2	78.57	5.60	7.02	1.11	18,320	420	3.35
3	78.76	5.70	7.09	1.13	18,400	500	2.80
4	76.81	5.28	8.41	1.10	18,010	110	0.61
5	76.94	5.35	8.22	1.11	18,100	200	1.12
6	79.41	5.60	7.14	1.18	18,280	380	2.12
16	79.41	5.51	6.36	1.15	18,270	370	2.06
17	81.12	5.51	4.36	1.18	18,400	500	2.80
18	76.59	5.26	6.22	1.06	18,200	300	1.67
7	78.42	5.56	8.25	1.09	18,180	280	1.56
8	77.19	5.33	9.05	1.12	17,970	70	0.39
9	77.64	5.22	7.74	1.05	18,000	100	0.56
10	79.02	5.50	6.92	1.16	18,240	340	1.90
11	78.66	5.33	7.83	1.16	18,030	130	0.73
12	77.44	5.46	8.31	1.18	18,140	240	1.34
14	78.77	5.41	8.08	1.14	18,060	160	0.90
	Averages				18,182	282	1.57

for each class of fuel, thus if the engineer knows to which class the fuel he is using belongs, he knows its intrinsic heating value; second, it serves as the basis for the very simple formulas as developed in following articles, by means of which he can readily determine in detail all the heat losses up the chimney as well as all other factors necessary or desirable for him to know, regardless of the variation of the pound heating value due to the variable amounts of ash and moisture his fuel may contain. To be able to do this, however, the per cent of CO_2 and CO contained in the flue gas and the temperature at which it leaves the boiler must be known.

Instruments that graphically record these data are available and every up to date boiler installation should be equipped with them.

The objection that may be raised against the pound carbon fuel unit is that since the weight of the non-combustible constituents contained in fuel per pound of carbon are variable, the weight of the pound carbon unit must also vary. This objection, however, has no bearing on the control of boiler operation based on the pound carbon unit. Heat losses, no matter by what formula they are calculated, are always expressed in percentage of the heat contained in the unit on which the formulas are based, therefore it does not matter on what unit of weight the loss is based, because

$$\frac{\textit{Heat loss per pound} \times 100}{\textit{heating value per pound}} = \frac{\textit{Heat loss per P.C. unit} \times 100}{\textit{heating value per P.C. unit}} = \textit{per cent loss.}$$

If the heating value of the fuel is known or the ultimate analysis of the fuel is known, the weight of the pound carbon unit can easily be determined by either of the following two formulas, whenever necessary or desirable:

(*a*) $\dfrac{\textit{Heating value per P.C. unit}}{\textit{heating value per pound of the fuel}} = \textit{weight of pound carbon unit}$

(*b*) $1 + \dfrac{\textit{The sum of all constituents except carbon in per cent}}{\textit{Per cent of carbon}} = \textit{weight of the pound carbon unit}$

Applying these formulas to the coal used in tests 17 and 18 that contained respectively the highest and lowest per cent of total carbon, we have:

Test 18, formula *a*, $\dfrac{17{,}900}{14{,}493} = 1.235$ pounds.

Test 18, formula *b*, $1 + \dfrac{5.51\,H + 4.36\,O + 1.18\,N + 0.77\,S + 7.04 \text{ ash}}{81.12\,C} = 1.232$ pounds

Test 17, formula *a*, $\dfrac{17{,}900}{13{,}689} = 1.308$ pounds

Test 17, formula *b*, $1 + \dfrac{5.26\,H + 6.22\,O + 1.06\,N + 1.09\,S + 9.78 \text{ ash}}{76.59\,C} = 1.30$ pounds

This shows that these two formulas give practically identical results so that the weight of the pound carbon unit of fuel can readily be determined when either the ultimate analysis or the pound heating value of the fuel as fired is known. But since the heat losses as well as efficiency are always expressed in percentage of the heat consumed, the weight of the fuel unit on which the calculations are based is immaterial.

The fact that the pound carbon fuel unit is practically equicalorific renders the control of economic boiler operation quite independent of the variation in heating value of the coal used and in addition lends itself to establishing simple formulas by which the heat losses can be easily determined and analyzed.

The next article of this series will contain the development of the formulas, based on the pound carbon fuel unit, for finding the heat lost in the flue gas.

Answers to What Do You Know

The questions are on page 969

Ans. 1—The temperature ranges from 120 to 175 deg., depending upon the amount of hot gases blowing past the piston.

Ans. 2—The actual weight of carbon in the chimney gas comprised in even very heavy black smoke is probably only a small fraction of one per cent of the coal burned, but the conditions under which smoke is formed are just the conditions under which monoxide is formed in greater or less quantities, with considerable loss of heating value. The heat loss due to the unburned solid carbon particles forming the smoke is doubtless negligible, but along with the smoke there are likely to be other losses of considerable magnitude. Smoke elimination usually saves money.

Ans. 3—Fire-tube boilers are usually hand fired and have natural draft. The furnace temperature is seldom as high as in case of water-tube boilers, which are frequently stoker fired and have forced draft. Even with equal furnace temperatures the water-tube boiler furnace wall, being higher, may be expected to fail before the lower furnace wall of the fire-tube boiler fails.

Ans. 4—The pump is operated against a head substantially greater than the boiler pressure, and a reducing valve or constant excess-pressure governor is placed in the line between the pump and the feed-water control valve. The pump speed can drop as much as 25 per cent before the delivery pressure falls below the boiler pressure.

Ans. 5—The velocity of the water is that due to gravity and remains practically constant at all loads.

Ans. 6—In one method the water level in the boiler determines the rate of water flow. A second method combines the steam flow from the boiler and the water level in the drum to determine the rate of feed.

Ans. 7—Some headers are made by taking a steel plate and shaping it into a long box, after which the joint is forge welded. The header is then given its serpentine shape. Other headers are made from a square drawn tube which is heated and shaped.

Ans. 8—From 20 to 50 hours.

Ans. 9—The single-pipe system has no advantages save that of cheapness of installation and the double-pipe gives a more positive circulation.

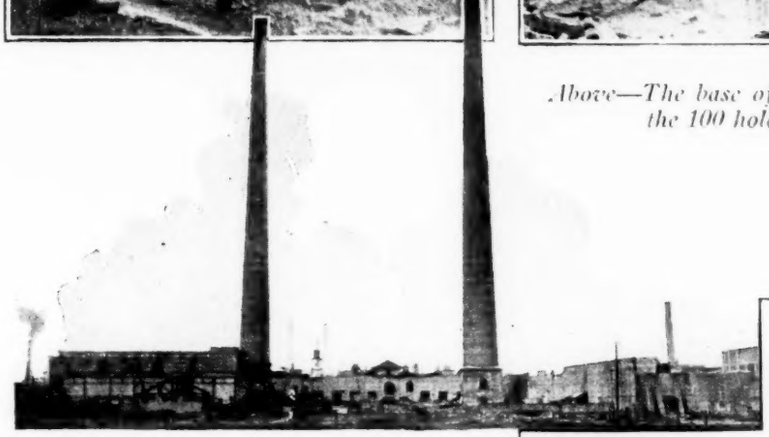
Ans. 10—In a lap winding there are as many circuits as there are poles in the machine, but the wave winding has two circuits only, irrespective of the number of poles. The former is frequently called a parallel winding and the latter a series winding.

Increase in Power Equipment—The most tangible factor as revealed by the census returns is the increased capacity of power equipment in the industries. In this period, while the population increased 54 per cent and the number of persons engaged in the manufacturing industries increased 87 per cent, the installed capacity of primary horsepower increased 256 per cent. In 1899 the industries had 2.1 hp. to each worker, and in 1925 they had 4.3 hp. to each worker.—*Monthly Review by Natl. City Bank of N. Y.*

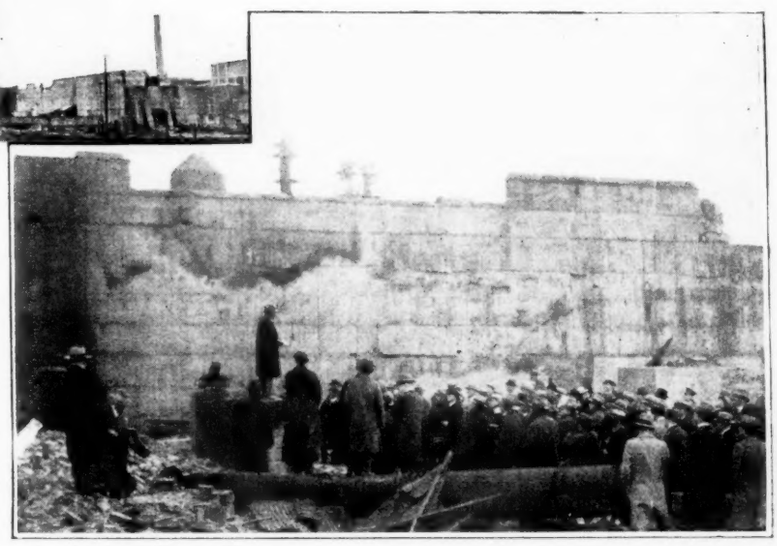
The Tallest Chimney Ever Dynamited

IT REQUIRED the explosion of 105 lb. of dynamite to fell this 365-ft. chimney which was constructed in 1900 by the Alphons Custodis Chimney Construction Company. This chimney, the first of its kind in America and one of the tallest east of the Mississippi, was 10 ft. inside diameter at the top and weighed 4,000 tons. The brick walls were 5 ft. thick at the bottom and 11 in. thick at the top. In falling it broke in three places and measured 265 ft. on the ground, having shortened 100 ft. in its fall.

Above—The base of the stack after the first blast. A few of the 100 holes used for dynamiting can be seen



Above—How the chimneys at the abandoned plant of the International Nickel Company, Bayonne, N. J., looked before dynamiting



Right—Chief engineer Clark, designer of the stack, telling a group of engineers how the job will be done

ELECTRICAL *Operation and Maintenance*

Large Induction Motors

Designed for High Speed

By R. R. SHEELY and P. C. SMITH*

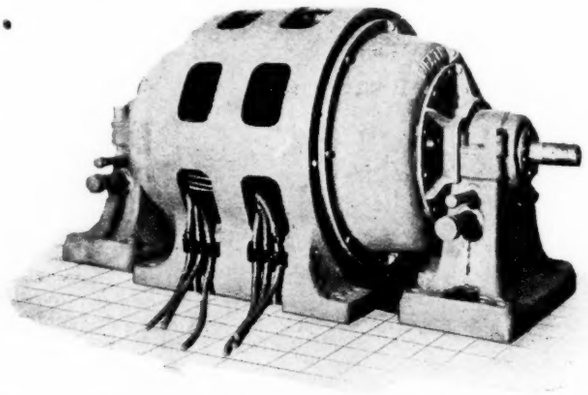


Fig. 1—Sixty-cycle 3,550-r.p.m. squirrel-cage motor for direct connection to boiler-feed pump

HIGH speed inherently favors the electrical design of an induction motor, giving less active material per horsepower, less losses and less magnetizing kilovolt-amperes, which results in improved efficiency and power factor. High speed, however, is not so favorable to the mechanical design because of the limitations in physical strength of materials.

In speaking of high-speed motors one usually thinks of high revolutions per minute, and this is natural, for the two usually go hand in hand. But revolutions per minute alone is not a criterion; the diameter of the rotating element must also be considered. The construction of the rotor is such that most of the mechanical stresses are dependent on the peripheral speed, and hence the designer classifies motors on this basis rather than the revolutions per minute.

How Best Performance for Normal Speeds Is Obtained

For normal speeds the best performance is obtained by using a large-diameter rotor and relatively short core length, the rotor punchings and windings being supported by a cast-iron or steel spider which is pressed on the shaft and keyed in place. With higher speeds the maximum diameter is limited by the peripheral velocity. This, combined with the deeper core required with the small number of poles, decreases the inside bore of the rotor punching to a size only slightly greater than the minimum shaft diameter permissible to give the required rigidity.

If an attempt is made to use a cast spider in this case, the large hub and arms required for mechanical strength will occupy valuable space that could otherwise be used to advantage in admitting a larger volume of cooling air to the center of the core, to be forced out through radial vent ducts by the blower action of the fingers used as spacers. With moderately high speeds it may be advisable to use a larger volume of active material at correspondingly lower densities so that less cooling air is required, but as the speed is increased, a point is reached where this method merely tends to decrease the space available for admitting ventilating air, and other means must be employed.

By increasing the shaft diameter and milling axial slots to take the place of the openings between the cast spider arms, as in Fig. 2, the punchings may be mounted directly on the shaft with considerable economy of space and material. This increased shaft diameter results in increased rigidity so desirable at high speeds, while the area of the air inlet to the rotor will be the maximum obtainable for a given inside diameter of rotor punching. With the fluted construction the additional fit between the spider and shaft is avoided, giving a sturdy rotor. This is especially desirable where vibrations or shocks are encountered such as frequent starting on full voltage or plugging service.

One-Piece Rotor Punchings

When it is practicable to do so, the rotor punchings are made in one piece. They are then self-supporting and the spider or shaft is relieved of all stress due to centrifugal force save the stress of its own weight. This allows the use of a light spider or shaft, giving a greater air intake area. Fig. 3 shows two typical one-piece rotor punchings. For particularly small diameters the punchings are made as shown at *B*. These punchings are mounted directly on the shaft and the ventilating air enters through the axial ducts *C*. When a spider or fluted shaft is used, the punchings are made as at *A*. In this case radial ventilation is used, the air entering through the spider or fluted shaft to radial ventilating ducts in the core.

When the diameter is so large that a one-piece punching is uneconomical, segments are used, Fig. 4. Two

*Motor engineers, Westinghouse Electric & Manufacturing Company.

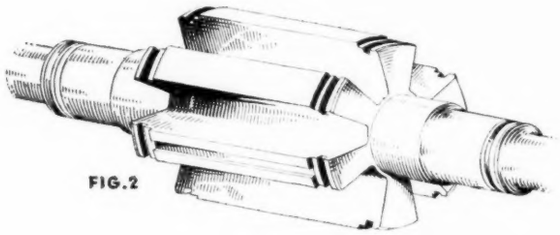
ELECTRICAL *Operation and Maintenance*

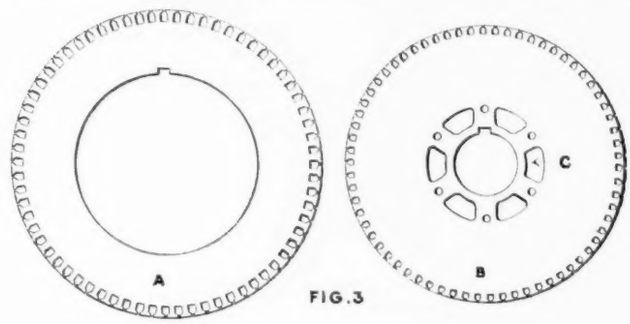
large dovetails on each segment hold it securely to the spider. In building the core, the segments are shifted one dovetail with each successive layer of punchings, so that the gap between segments in one layer will come in the center of a segment of the adjacent layer. That is, the segments are staggered when the core is tightly pressed, friction between layers gives somewhat the effect of a one piece punching. The segments may be still more securely tied together by driving pins in holes provided near the lower edge of the punching.

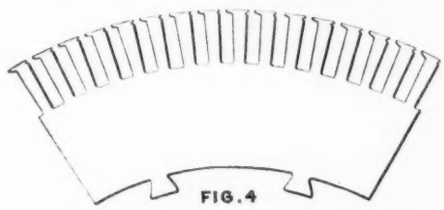
The stator punchings of high-speed motors are little different from other motors except that the small number of poles necessitates a deep yoke in order to carry the flux without excessive magnetic drop. Good quality silicon steel for low core loss is generally used in the stators of high-speed motors.

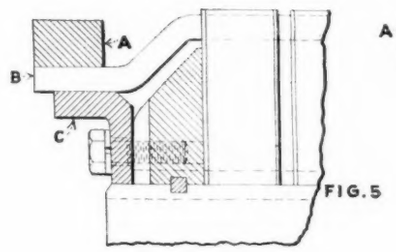
Fig. 2 to 7—Parts of high-speed rotor for squirrel-cage type motor

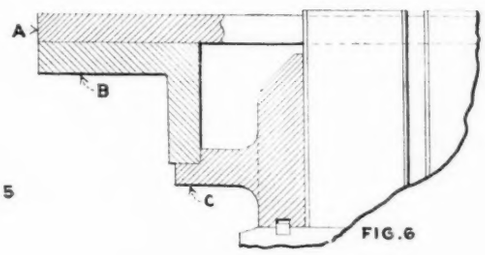
Fig. 2—Fluted shaft on which the rotor core is assembled. Fig. 3—Typical one-piece rotor punchings for high speeds and small diameters. Fig. 4—Typical segmental rotor punching for high speeds and large diameter. Figs. 5 to 7—Sections of squirrel-cage windings, showing resistance ring, bar and centering ring. *A*, resistance ring; *B*, rotor bar; *C*, centering ring.

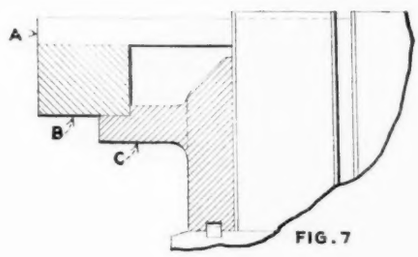












The squirrel-cage winding is much better suited mechanically for high speed than the phase-wound rotor, and it is used wherever operating conditions will permit. The end ring should be supported from the end plate or shaft at several points, so that it will be centered accurately. This is necessary, since slight shifting of the ring would cause unbalance and vibration of the rotor. In the end-ring material high tensile strength and high conductivity are necessary. Good quality brass or bronze fills these requirements nicely. Joints between the bars and the rings are also important, and a construction in which this point is not subjected to centrifugal force is desirable. This may be obtained by dropping the bars after they leave the slots and welding or brazing the ring on the outside, Fig. 5. In the usual construction the ring is on the inside, as indicated in Figs. 6 and 7. The drop-bar construction has the disadvantage of being expensive and requires considerable labor for assembly. By milling a slot in the ring and brazing the bars into these, a good mechanical and electrical joint is secured.

Group Winding for Phase-Wound Rotor

For the phase-wound rotor the group winding is usually employed, since it permits chording which reduces the end-turn extensions and also the number of connectors when several turns per coil are connected in series. Fig. 9 shows the usual method of bracing the end turns to prevent shifting. The coil-supporting ring is usually cast integral with the end plate, and the insulation channel *C* gives the proper creepage distance for the voltage employed. The cross-connections are cleated to the inside surface of this ring so that centrifugal forces merely tend to hold them more securely in place and no current-carrying member takes any direct stress.

The rotor coils are designed to wind as tightly as possible, and after the winding is in place fuller-board spacers are forced between the end turns until the winding is packed solid. The band wire is then put on over a layer of insulation. This band is a continuous strand of steel wire wound on under tension to make it tight enough to prevent shifting of the coils as the motor

ELECTRICAL *Operation and Maintenance*

comes up to speed, since this would injure the insulation and destroy the balance. High-grade insulation must be used throughout, as any deterioration under the high pressures encountered would allow the coils and connec-

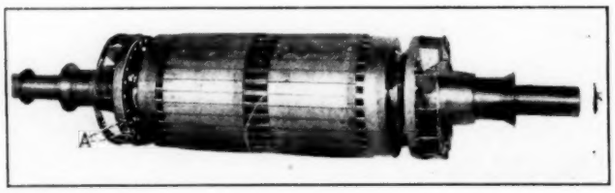


Fig. 8—Squirrel-cage rotor for high-speed motor shown in Fig. 1

tions to shift, resulting in unbalance and further injury to insulation.

If an attempt is made to follow the normal arrangement of collector and winding on extremely high speeds, the distance between bearings becomes so great that a very large shaft diameter will be required to keep the deflection within safe limits. In this case a collector large enough to fit this shaft would give a high ring speed with unsatisfactory collection of current. By using a shaft hollow through one bearing and placing the collector and brush rig on the outside, the distance between bearings is decreased and the size of the shaft required for the same stiffness is reduced.

Needless to say, high-speed motors must be accurately balanced. Balance weights have been fastened to rotors in various places such as on the spider arms, end plates, blowers, etc. When the diameter is large enough to give easy access to the interior of the spider, it is customary to cast wedge-shaped pockets on the inside of the spider arms. When the weight necessary to balance the rotor has been determined, this amount of molten lead is poured into the correct pocket, the wedge shape holding it in place. When the diameter is too small to permit this, the weight may be bolted to the blower or some other substantial member.

When machines are produced in quantity it is quite important that means be provided for quickly attaching the balancing weights, or considerable time may be consumed in this operation. The largest activity is in the smaller machines, and these are so compact it is difficult to find a place to attach a weight. A continuous ring, such as shown in Fig. 8, is one of the best methods for attaching weights. This ring is drilled and tapped at regular intervals to receive screws or bolts, as shown at *A*. Screws of different lengths are used when fine adjustment is necessary.

Ventilation of High-Speed Motors

From the point of view of ventilation high-speed motors are distinctly different from low-speed machines, the difference being in the air velocity and the use of axial ventilation in some cases. Motors may be self-ventilated, supplying the cooling air by blowers attached to the rotor, or forced ventilation, having the air supplied by an external blower. The rotor of a radially ventilated machine is in itself an effective blower, the spacers in the radial ducts serving as blower vanes. However, it is usually necessary to provide a blower on either end of the rotor

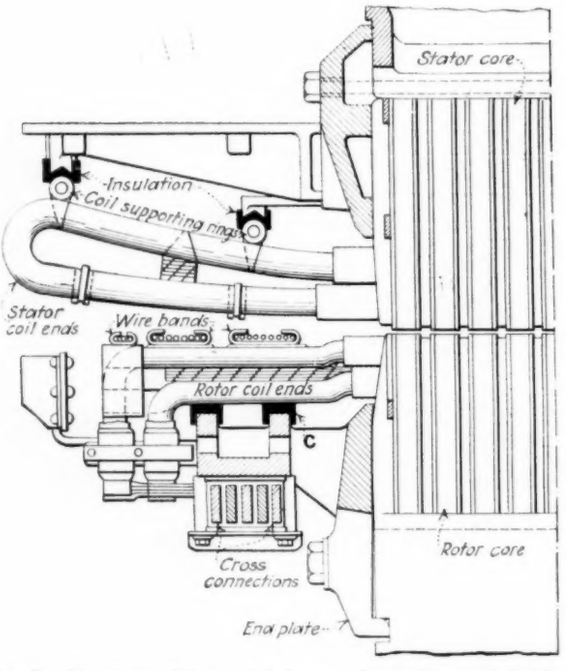


Fig. 9—Section of large high-speed machine with phase-wound rotor showing support and bracing of windings

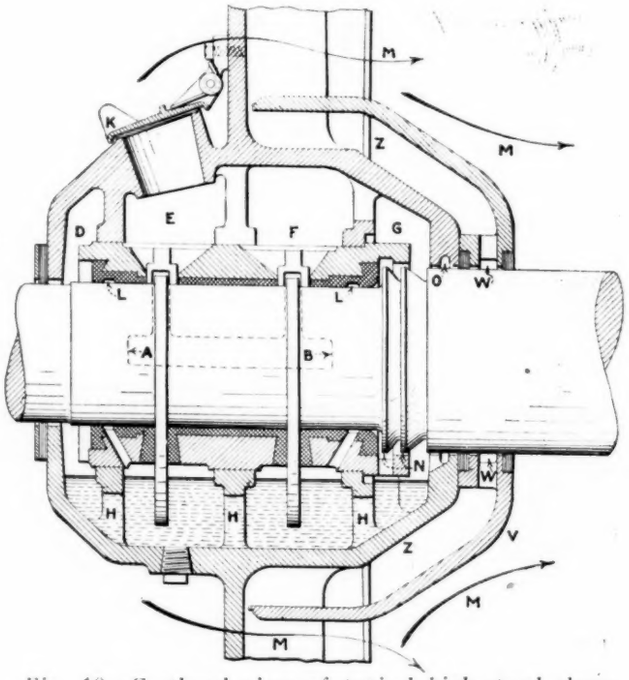


Fig. 10—Sectional view of typical high-speed sleeve bearing, showing air-pressure equalizer at V

ELECTRICAL *Operation and Maintenance*

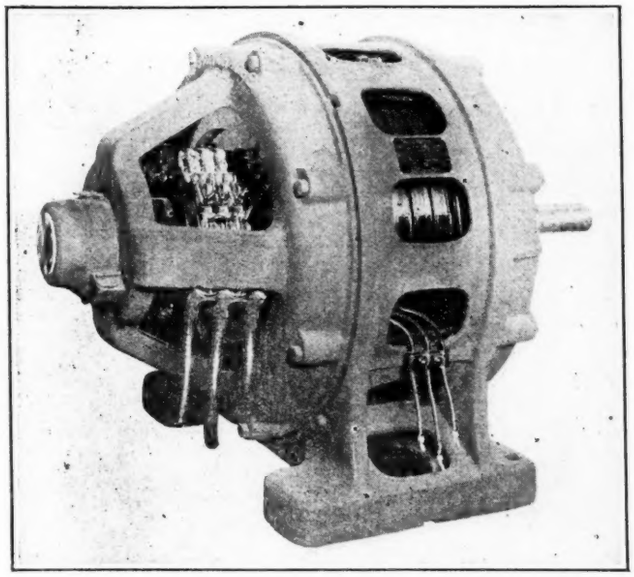


Fig. 11—Bracket-type, 400-hp. 1,775-r.p.m. 60-cycle wound-rotor motor

to supply cooling air to the end turns of the primary winding. Fig. 8 shows typical sheet-steel blowers on a high-speed rotor. These blowers are made for only one direction of rotation, and advantage has been taken of specially shaped inclined vanes to reduce the windage loss and noise and to give higher pressures. If the motor must operate in either direction, however, it is necessary to use radial-type vanes.

Owing to the high velocity of the blower vane as compared to the entering air, high-speed blowers have relatively low efficiency, and on a large installation the use of a separate low-speed blower for forced ventilation may mean a considerable saving in improved blower efficiency. A separately driven blower also has the additional advantage in the flexibility in the quantity of air delivered, the speed being reduced when the motor is running idle or at light loads, effecting a saving in power. Of course, forced ventilation means totally inclosing the motor, and the initial cost of this may more than outweigh the advantage of improved blower efficiency.

Improved Sleeve Bearings

An idea of a typical sleeve bearing with its housing may be had from Fig. 10. The bearing proper consists of a cast shell lined with babbitt and held in place by three annular supports that are cast in the housing. Slots are provided in the top half of the bearing for two oil rings, which hang on the shaft and are large enough in diameter to reach to near the bottom of the oil reservoir. In the figure the bearing is cut away at the center line, between points *A* and *B*, nearly the full length of the bearing to give a wedge shape that facilitates the entrance of the oil. Clearance is provided between the bearing and shaft for the oil film, and the bearing is made slightly eccentric to improve the wedging action. Oil leaving the bearing at the end is caught by the annular groove *L* and leads back to the oil reservoir through a hole at the bottom of the groove. Any oil flowing along the shaft is thrown off by the oil throwers *N*.

The annular supports divide the bearing housing into four chambers, *D*, *E*, *F* and *G*. These supports are perforated both above and below the oil level to insure equal air pressure and uniform oil level. Passages *H* are provided so that the surface of the oil is not interrupted by the supports, reducing any splashing or surging of the oil. Openings are provided at the top of the bearing so that the oil rings may be readily inspected through openings at *K*.

The high velocity of the ventilating air in high-speed motors, the path of which is indicated by arrows *M*, results in low pressure on the interior of the motor. For economy of space and material the bearings are usually placed as close to the motor as practicable, and when the diameter of the rotor is large enough, the end of the bearing may even project into the interior of the rotor. Hence, sometimes there is considerable difference in pressure between the front and rear ends of the bearing. This difference in pressure causes air to flow through the bearing housing into the motor, taking with it a small quantity of oil. Some of this oil will be deposited on the motor windings, and although the amount is small, the continuous accumulation may in time cause insulation failure.

Preventing Oil Leakage

Some of the special features added to prevent oil leakage are shown in Fig. 10. All openings in the housing are sealed to make them as nearly airtight as practicable. Felt is used under the overflow and sight-hole

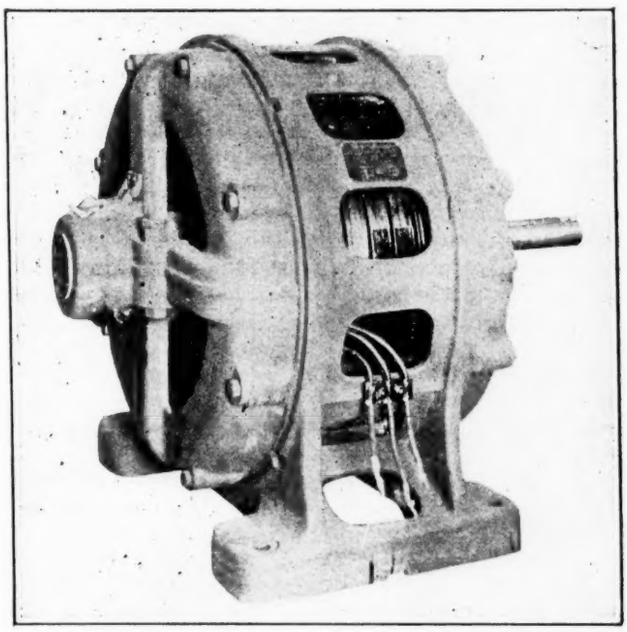


Fig. 12—Bracket-type 400-hp. 1,750-r.p.m. 60-cycle squirrel-cage motor

ELECTRICAL *Operation and Maintenance*

covers and around the shaft. The top and bottom bracket halves, after being carefully machined to fit tightly together, are sealed with cement to prevent air leaking through the split and a special attachment *V*, called a pressure equalizer, is fastened around the housing as shown. This attachment consists of a casting made to fit over the inner nose of the bearing housing, providing an air chamber at *W*, which is connected with the outside atmosphere by closed air passages *Z*. This gives approximately atmospheric pressure at the inner end of the bearing housing, thus equalizing the pressure on the front and rear and eliminating the tendency for air to flow through the housing.

Running-In High-Speed Bearings

Another problem encountered in high-speed bearings is high temperature This often occurs when the bearings are first placed on test, and it is usually caused by high spots in the lining or slight misalignment. When the bearings have been scraped and worn in by running the motor several hours, the temperature drops to normal. All high-speed bearings are properly scraped and worn in before the motor is allowed to leave the test floors. This procedure insures these machines going into operation with no more bearing trouble than standard motors.

Since high-speed motors are for coupled service, there is but little pressure on the top half of the bearing and small contact surface is used there, facilitating the wearing-in process. The extra large clearance between the bearing and shaft permits a large quantity of oil to flow through and take away the heat. For most machines oil-ring lubrication is satisfactory, but in some cases the heat to be dissipated is unusually large and gravity or forced-feed lubrication is used. Pressure forces the oil rapidly through the bearing and the heat is thus taken away. The large volume of oil used in these systems usually insures cool oil, but a cooler can be placed in the oil circuit if advisable.

Motor Applications

The extensive electrical development that has been going on in recent years and the increasing demand for reliable power at low cost, has made the present-day generating plant a model of reliability and efficiency, and the induction motor has played an important part in this development. Its sturdy construction and simplicity of installation and control have forwarded its use on practically all power-plant auxiliary drives. The high steam pressures employed require high-speed boiler-feed pumps, an ideal application for a direct-connected high-speed motor.

Since the higher-speed motors are smaller for the same horsepower rating than the low-speed machine, the tendency on all auxiliaries has been toward higher speeds in order to save space and reduce the initial cost. For the same reasons high-speed motors are being extensively applied in various other fields, such as on pumps for high-pressure city water supplies, blowers for wind tunnels, circulating pumps and blowers for industrial plants, centrifugal separators and gyroscopes.

Starting Diesel Engine by Using Generator as a Motor

OUR power foreman does not entirely agree with the answer to Question 7 in "What do you know?" in the Oct. 11 issue.

He had occasion recently to start a 2,000-hp. synchronous motor in a similar manner. The compensators were out of order, and unless the machine was started there would be a loss of thousands of dollars in mill output.

The mill where the motor was installed was fed from the power station through a double bus. One bus was always held in reserve.

The operating bus was disconnected from the system by means of a switch. One of the engines in the station was taken off the system and connected to the reserve bus feeding the mill in question. The motor was next connected to the line and the engine started. As the engine speed increased, the motor started as an induction motor would start. When the motor was up to speed, the field switch was closed and the machine operated as a synchronous motor.

Our foreman claims that the voltage induced in the field winding is not sufficient to do any damage, especially if the machine has a damper winding. Furthermore, the surge of current caused by closing the field switch after the machine is up to speed is not harmful. He would start the Diesel-driven unit referred to in the question the same way he started the synchronous motor.

Chicago, Ill. Roland C. Laney.

Starting the Diesel unit in the way suggested by M. E. Wagner, in the Oct. 11 issue, would hardly be practicable, although starting in a similar way has been done with direct-current generators. I have never heard of its being successfully used with alternators. The alternator would have to act as a synchronous motor, and although an alternator can operate as a synchronous motor, it can start approximately no load only. Starting a Diesel engine would impose a heavy load and although an alternator will run as a synchronous motor, it will not be self-starting unless special arrangements are made in its

Starting as suggested, even if possible, would hardly be advisable, owing to the large current that would be drawn from the steam-engine-driven generator, and the high voltages that may be induced in the field windings of the Diesel unit while starting as a synchronous motor might prove to be dangerous to the insulation.

Apparently, the air starting bottles are charged direct from the engine. It would be advisable to install a small motor-driven compressor and charge the bottles with this if necessary.

On synchronous motors the pole-face windings are designed for developing a good starting torque, where such windings, when used on alternators, are designed for stabilizing the operation of the machine. For stabilization the pole-face windings are made with a low-resistance and may not develop sufficient torque for the alternator to turn over a Diesel engine used as its prime mover. W. E. Warner.

Brentford, England.

REFRIGERATION *for the Engineer*

Turbo-Compressors For Refrigerating Purposes*

By Dr.-Ing. Heinz Voight

THE recent development by the rapidly growing chemical industries of processes that require refrigeration has created a demand for refrigerating machines of much larger capacity than those in use for ice-making and cold-storage. This has led recently to the use of turbo-compressors.

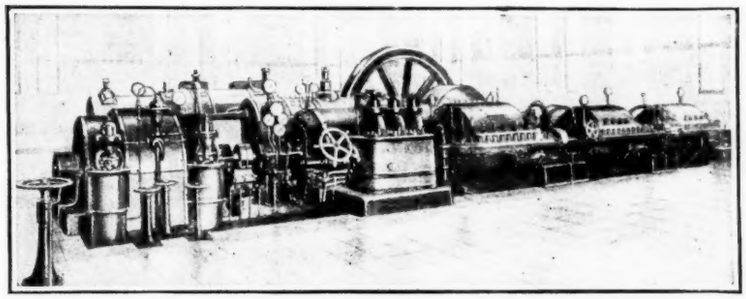


Fig. 1—View of 2,000-ton turbine-driven turbo-compressor

About four years ago Sulzer Bros. built for a chemical manufacturer a two-stage tandem ammonia compressor driven by a single-cylinder contraflow poppet-valve engine rated at 1,250 i.hp. at 150 r.p.m. with steam at 353 lb. pressure and 662 deg. F. temperature. The cylinder diameters of the compressor were 22.5 and 29.4 in. respectively, with a stroke of 28.6 in. A jet intercooler is provided between the cylinders.

This compressor satisfied its owners with its performance for over three years. Then at least 2,000 tons per day additional refrigerating capacity became necessary, and lack of space in the power plant to accommodate the required reciprocating unit or units was responsible for the decision to install a turbo compressor, rated to deliver between 2,000 and 2,500 tons of refrigeration per day.

The turbo-compressor offers the following advantages: No oil in the exhaust; no oil in the ammonia vapor; small floor space occupied; small foundations; no shock or vibration in the piping; small oil consumption and no danger of damaging the compressor by operators' mistakes.

The disadvantages are the higher steam consumption when the turbo unit is small. In the larger sizes, when operating condensing, the turbo-compressor will show a higher economy than the reciprocating type.

In Fig. 1 the Brown, Boveri Co. compressor selected is shown, with the flywheel of the reciprocating unit in the background. The two-stage steam turbine is divided into two sections with separate housings. The high-pressure stage of the steam turbine is located next to the compressor, thereby affording better access to the outboard low-pressure stage with its condenser connection. The design permits the low-pressure stage to be cut out of service, while the high-pressure stage is operated against back pressure. The compressor is divided into three stages and is so connected that the high-pressure stage can be cut out of service during light load. One of the stages is shown in Fig. 2. Surface air intercoolers are installed between the stages. These intercoolers are divided into two sections, to permit cleaning without cutting out the intercooling entirely.

Surface intercoolers are decidedly preferable to the injection type, into which 15 per cent of the liquid ammonia must be introduced to obtain the same cooling effect. This ammonia vaporizes and must be compressed by the succeeding compressor stage.

The most important conditions under which this turbo-compressor must operate are: Steam pressure, 354 lb.; steam temperature, 662 deg. F.; bleeder pressure, 44 lb.

The specified characteristics of the units are shown by the curves in Figs. 3 and 4. These show in four groups the relation between the temperature of liquefaction and the tons of refrigeration per hour for different rotative speeds. The groups are drawn for vaporizing temperatures of —5, —10, —15 and —20 deg. C.; corresponding to 23 deg., 14 deg., 5 deg. and —4 deg. F. respectively. The finer lines are curves of uniform power consumption. The broken lines are curves relating to the compressor with high-pressure stage cut out of service. The guarantee is based on the following data:

Refrigeration, tons per hour	82
Steam consumption, cu.ft. per min.	6,091
Weight of ammonia, lb. per sec.	12.45
Vapor pressure, lb. abs.	35.28
Liquefaction pressure, lb. abs.	174.93
Vapor temperature, deg. F.	5
Liquefaction temperature, deg. F.	86
R.p.m.	6,000
Brake horsepower	2,365

The characteristic curves show the theoretical versatil-

*Abstracted from *Zeitschrift Des Vereines Deutscher Ingenieure*, Aug. 13, 1927.

REFRIGERATION *for the Engineer*

ity of the turbo-compressor, this being exceeded in practice. The entire range in performance from 41 to 111 tons of refrigeration per hour, is achieved with only a 10 per cent difference in rotative speed, whereas a speed ratio of at least 3 to 8 would have to be obtained to secure like results with a reciprocating compressor.

The power saving due to the intercooling is plainly evident in operation. The subcooling of the liquid to 35.6 deg. F. is obtained by passing it through a sodium-brine cooler which is located at the condenser outlet. This increases the refrigerating effect for any given volume of circulating ammonia. In this sodium-sulphate plant the relatively warm strong liquor is cooled by the weak liquor from which most of the crystals have been frozen out by a suitable heat interchanger, which further reduces the refrigeration required.

The over-all length of the turbo-compressor is 38.68 ft. The section of the low-pressure compression stage illustrated by Fig. 2, shows the operating mechanism of the movable diffuser. The shaft stuffing boxes are oil sealed, the oil being maintained at a constant excess pressure over the gas pressure by a governor on the oil pump.

The flanges of the horizontally split casing are provided with catch gutters to receive any escaping ammonia; a partial vacuum is maintained in these gutters by a special air pump. The mixture of air and ammonia discharged by this pump is passed through separating apparatus to recover the ammonia.

Turbine compressors operating at compression ratios of 5 or over are not economical if the volume compressed is less than 1.76 cu.ft. per min. unless they are built with very small diameter rotors and are running at extremely high speeds. Such machines are subject to many mechanical difficulties, such as to the effect of critical shaft speed, clearance losses, inefficient bucketing, etc. If ammonia is to be used as the cooling medium, the turbo compressor is applicable only in capacities in excess of 300 tons of refrigeration per day.

For these reasons other mediums are often chosen, such as sulphur dioxide, butane or ethyl chloride, which at 32 deg. F. require volumes of from 2, 4.4 and 7 times that of ammonia vapor. If water vapor were used, even much smaller capacity turbo compressors would be practicable, because the required saturated volume would be 1,300 times that of carbon dioxide. But such an enormous vapor volume would shut out turbo-compressors from competition with reciprocating compressors using another medium.

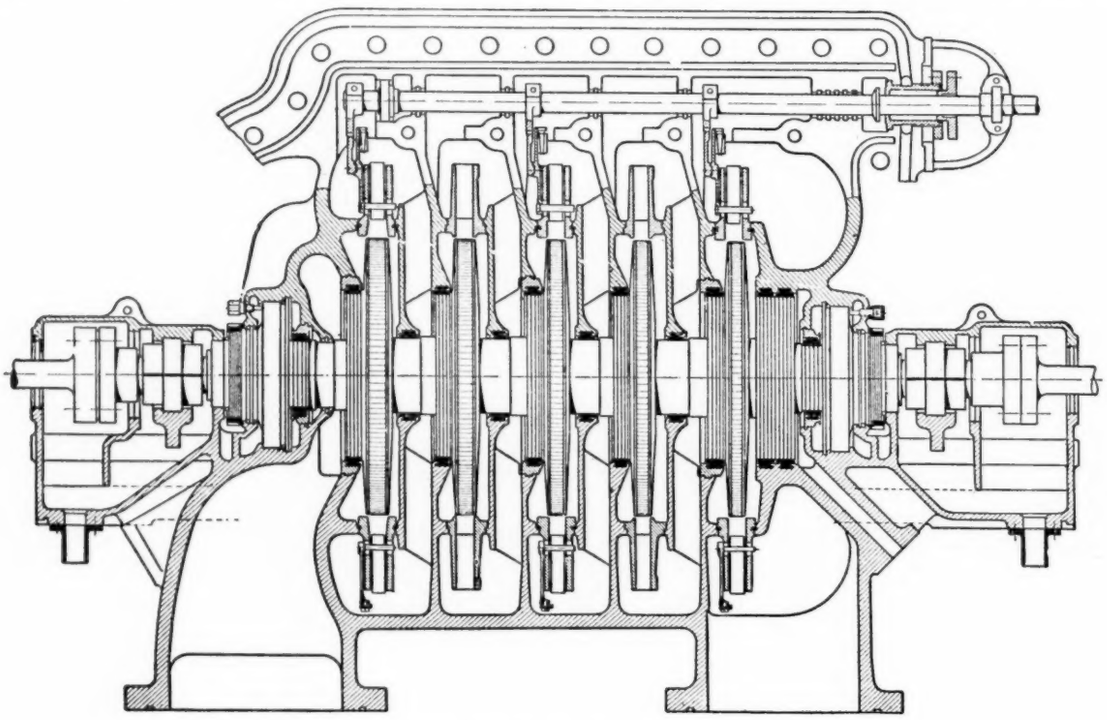


Fig. 2—Cross-section of one of the stage units

TABLE I—MAXIMUM REFRIGERATION IN TONS PER HOUR

Refrigerating Medium	32 deg. F	14 deg. F.	—4 deg. F.	—22 deg. F.
CO_2	27.6	220	165	110
NH_3	82.5	55	37.5	23
CH_3Cl	41.4	27.6	19.3	12.4
SO_2	30.4	21.1	12.4	8.3
C_4H_{10}	19.3	13.8	9.7	6.9
C_2H_5Cl	12.4	8.3	5.0	3.0
H_2O	0.23	...	...	...

Although with falling temperatures of vaporization, the suction volumes of the mediums increase, it is not possible to set the minimum capacity at a low point, because with increasing compression ratios the final volume would become too small. But there is no theoretical limitation as to the ultimate maximum capacity to which

REFRIGERATION *for the Engineer*

the turbo-compressor is applicable. For a 51-in. diameter compressor rotor, the upper practical limitations are as shown in Table I.

But for such high refrigeration output, mediums of a high saturated specific volume are not used. Their place is taken by CO_2 and NH_3, with which the advantages of the turbo-compressor are readily apparent.

For any given pressure ratio the number of rotors decreases in inverse proportion to the ratio of the specific

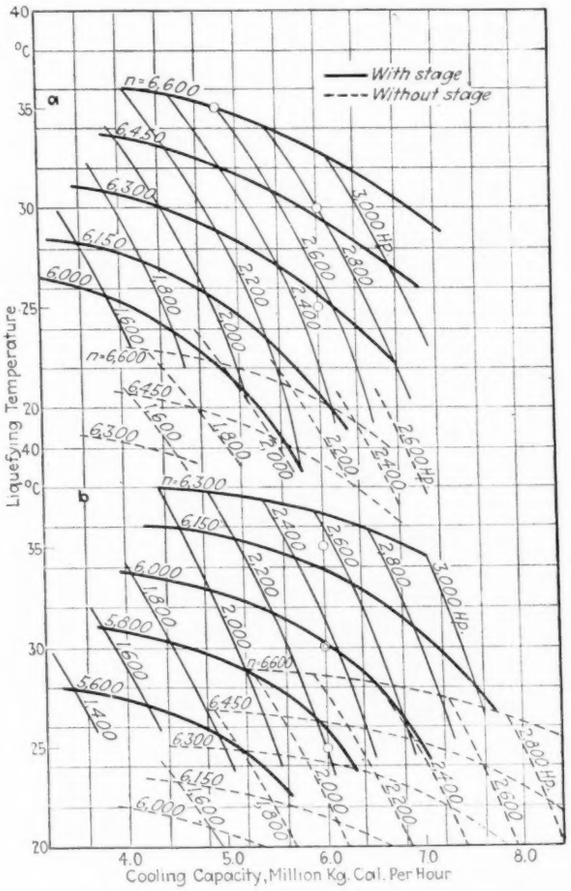


Fig. 3—Characteristic curves of turbo-compressor; a *is with —10 deg. C. suction and* b *with —5 deg. C.; curves marked* n *give speeds in r.p.m. with and without the third stage*

weight of the vapor to the pressure. In Table II the number of rotors required at 655 ft. per sec. rim velocity

TABLE II—NUMBER OF ROTORS REQUIRED FOR DIFFERENT MEDIUMS AT PERIPHERAL SPEEDS OF 655 FT. PER SECOND

Temp. of Vaporization deg. F.	CO_2	NH_3	CH_3Cl	SO_2	C_4H_{10}	C_2H_5Cl	H_2O
32	2	6	3	3	3	3	17
14	3	11	4	4	4	4	..
—4	4	15	5	5	5	5	..
—22	5	20	6	6	6	6	..

for vaporization temperatures between 32 deg. F. and —22 deg. F. and a liquefaction temperature of 77 deg. F. are given. It will be noted that three times as many rotors for ammonia and six times as many for water are required as for other mediums.

If the peripheral speed were increased to 1,310 ft. per second and the rotors were equipped with radial buckets, under average temperature conditions, a single rotor would suffice for all mediums except ammonia and water. This would greatly simplify the design, but the effi-

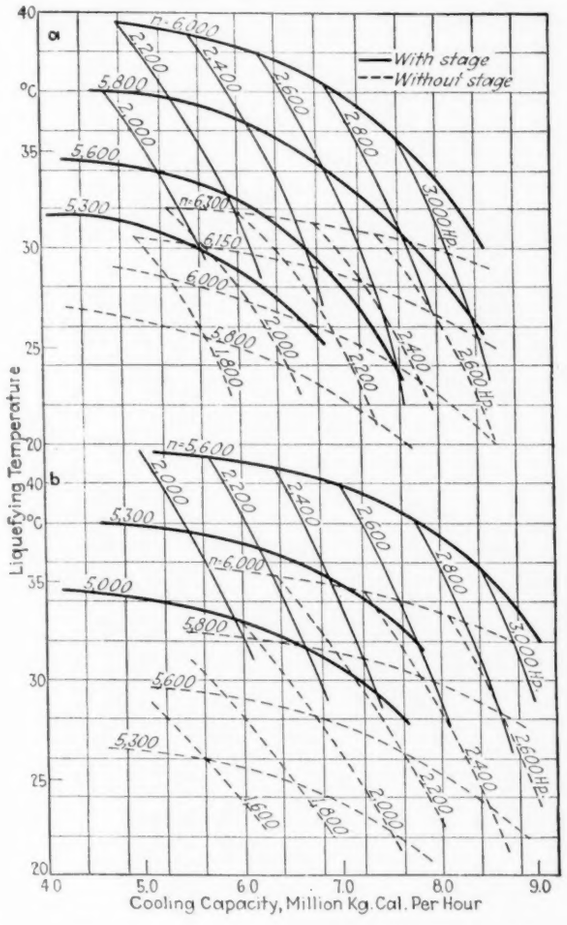


Fig. 4—Characteristic curves; a *with —20 and* b *with —15 deg. C. Suction temperature; curves marked* n *cover speed variations. (1 million kg. cal. per hour is equal to* $336\frac{2}{3}$ *tons of refrigeration per hour)*

ciency would be materially lessened. For instance, an ethyl-chloride compressor with a minimum hourly capacity of 35 tons, could be built with a rotor diameter of $7\frac{7}{8}$ in. A reciprocating ammonia compressor of similar capacity would be required to handle only one-seventh of the gas volume, and at 120 r.p.m. must have a cylinder capacity of 1,831 cu.in. Such a compressor would, therefore, occupy much more room than an equivalent turbo-compressor.

The compression exponent of a gas is a function of the number of atoms in its molecules. For di-atomic gases like air, its value is 1.4, for tri-atomic gases like

REFRIGERATION *for the Engineer*

CO_2, SO_2, etc., it is about 1.25, and for multi-atomic gases like ethyl-chloride C_2H_5Cl, falls off to about 1.1 or to nearly the unity exponent of isothermal compression. Consequently, the rise in temperature resulting from the compression of the multi-atomic gas is less. Intercoolers are, therefore, not as necessary or may be dispensed with entirely. For this reason multi-atomic mediums, such as ethyl chloride, can be used in turbo-compressors to advantage.

The initial cost of turbo-compressors ranging in capacities between 83 and 111 tons of refrigeration per hour is only about 50 to 60 per cent of that required for reciprocating compressors of like capacity, including the steam cylinders. The turbo compressors occupy only about one-third of the floor space of the assembled reciprocating compressor.

It must be remembered, however, that the choice between a turbo-compressor and a reciprocating compressor on a sound economical basis, depends on the individual requirements and operating conditions. The temperature and source of cooling water supply and whether or not the steam-driven unit is to operate condensing or exhaust against back pressure are important factors. Under certain conditions it may be possible to employ a reciprocating compressor as a high-pressure stage and a turbo-compressor as a low-pressure stage to advantage.

The fact that it is now possible to build refrigerating machines of large unit capacity, should be interesting to the men who are held responsible for the results obtained in large refrigerating plants. These large capacity units are, however, difficult to regulate if they are connected to various groups of vaporizing coils that alternately cut in and cut out of service as the conditions require and other coils are operating continuously. There is a tendency of unequal flow of ammonia vapor where this uneven distribution of the load exists. It is quite desirable that all vaporizing coils be similar in design and operate under similar conditions if good regulation is to be expected.

An entirely new field of application for large capacity turbo-compressors has been opened by the production of hydrogen from coke-oven gas for use in the synthetic manufacture of ammonia.

Nothing Is Insignificant in the Ice Plant

By C. T. Baker*

THE operation of an ice plant is, after all, a complex matter, and it is not surprising that difficulties occur. Surprisingly, though, most of these operating problems are due to minor details that are at first ignored by reason of their apparent insignificance.

Recently, I was asked to investigate a 10-ton electrically driven ice-making plant to determine the cause of the high power costs and the dropping off of capacity.

The plant had been in service about a year and had been installed by the owner without assistance from the machinery builders. When it was first put into service, everything operated satisfactorily, but with the approach of hot weather conditions began to change, and before long the capacity began to fall off while the power cost increased out of proportion to the size of the installation.

Investigation disclosed that it had been the practice to operate with the gage-glass valves closed on the liquid receiver, consequently it was impossible to know what the condition of the ammonia charge was, since these valves were never opened, even when charging the systems. The ammonia charge had been increased from time to time since the plant was first started, on the theory that additional ammonia was needed, with the result that in early August of this year the condensing pressure had increased from a normal value of 180 pounds to 225 pounds.

When the gage glass valves were opened, it was found that the receiver was full of liquid, and judging from the length of time required to lower the liquid level below the top packing gland when storing the ammonia temporarily in the ice storage room coils, the lower pipes of the double-pipe ammonia condensers were also full of liquid.

As there were no empty ammonia drums available, either at the plant or in the small town where it was located, it was not possible to draw out the surplus in drums, and as it was dangerous to continue to operate with such an overcharge, it was decided to release sufficient ammonia to the sewer to permit the liquid level in the gage glass to stand well below the top of the glass when the plant was operating normally.

After this was done, the condensing pressure did not exceed 180 lb. when the plant was again started, which netted a saving of 40 lb. below that obtaining with the plant overcharged. This of course materially reduced the load on the motor driving the compressor and resulted in some improvement in output. It was later found, however, that the tank coils had been improperly installed and that the suction and liquid connections to these coils were improperly made, which prevented the tank from operating efficiently and prevented the plant from producing its rated output.

As nothing can be done to remedy this condition until the close of the ice season, it will be necessary to continue to operate below capacity until the plant can be shut down for complete examination. A little judgment and engineering experience in the beginning would have saved a lot of trouble and expense.

Still another case of trouble occurred in a distilled-water ice plant where the ice showed a decided discoloration, beginning near the bottom and extending upward far enough to cause the loss of about 100 lb. of ice in each cake affected. An examination disclosed that the opaque portion of the cake was caused by raw water which was carried over from the boilers at frequent intervals when the boilers would prime and which occurred often enough to cause considerable trouble.

An investigation of the situation disclosed that the trouble was due to the plant's steam-piping arrangement. The boiler plant consisted of three horizontal return-tubular boilers connected together by means of a 4-in.

*Consulting engineer, Atlanta, Ga.

steam header. This header supplied steam to one 6-in. main steam line from which steam was taken for all purposes about the plant except for the boiler-feed pumps.

Two boilers were required to supply steam during the periods of maximum output, and with boilers 1 and 2 in operation, the total steam generated entered the header on the same side of the outlet tee to which was connected the 6-in. supply pipe previously mentioned. The result of this hook-up to a small diameter header was that the steam velocity in the header was so high with boilers 1 and 2 in operation that priming resulted.

As no means had been provided for draining the header, all water carried over by priming had to be worked through the various steam cylinders which exhausted into the atmospheric condensers, with the result that sufficient raw water found its way to the distilling system to produce the opaque appearance in the ice.

The trouble will be remedied by the installation of a larger header which is to be provided with suitable drain openings connected to a steam trap.

First Aid for Eye Injuries

By B. Franklin Royer, M.D.*

THERE are three cardinal principles of first aid after eye injuries. The first of these is cleanliness; next, prompt rest for the eye; and, third, medical care directed by a competent physician, preferably an oculist. These principles apply even if the injury is slight, and they are imperative with serious eye injuries.

In removing dirt, it is a common custom to lift the upper lid and to push the lower lid with its lashes over the eyeball well up under the upper lid and then to draw down the upper lid. This procedure often enables the lashes of the lower lid to drag out of the eye a bit of dirt or rough material that may be causing great annoyance. The method, however, has all the possibilities of introducing an equally annoying amount of dirt and, what is worse, of sometimes introducing directly from the soiled lashes germs that may find an ideal place to grow in the freshly scratched tissues from which the dirt was removed.

Cleanliness, then, is the first thing to think of. Refrain from pushing the lashes under the lids until the lashes have been washed and be sure that the fingers that are going to handle the lashes and lids are also thoroughly washed. Make certain that the medicine dropper or eye-cup that may be used has been thoroughly cleansed.

A rough bit of dirt blown into the eye may be comparatively harmless if removed quickly and carefully, but with rough manipulation through rubbing of the lids, the dirt may actually be driven into the tissues of the eye or may cause numerous scratches on the lining of the lids or of the conjunctiva covering the eyeball. Broken surfaces are thus exposed to all sorts of infection, and abundant opportunity is given for germs to be carried into the eye tissue with the original particle of dirt.

Make no attempt to remove particles of dirt from the eye until the hands and lashes have been thoroughly cleansed. Next, take a little twist of the cleanest of absorbent cotton, either twisted tight upon its own fibers with a little tufted tail piece, or twisted about a matchstick with a little tuft extending from the end. Separate the lids and note the location of the thing to be removed. With the prepared cotton it is usually safe very gently to drag the tailpiece over the thing to be removed. The cotton drags it out. If no cotton is available and the dirt is on the inside of the upper lid, then, after cleansing the lashes, the under lid may be pushed up under the upper lid, which should then be drawn down quickly, affording an opportunity to drag out the dirt with the lashes of the lower lid.

The corner of a perfectly clean handkerchief fresh from the laundry may be used like this cotton twist in removing dirt.

Many eyes are infected and some lost because of the introduction of germs from dirty hands, dirty handkerchiefs, dirty lashes or dirty materials used in attempting to do the kind thing for the individual suffering with dirt in the eye.

If much scratching occurred during removal of dirt or if dirt has been in the eye for a considerable length of time, great comfort may be had by gently placing a piece of soft linen that has been boiled and wet with cold water, over the eye and then very lightly bandaging the eye. This places the eye at rest, makes easier lifting lids from eyeball by the tears and favors start of the healing process. This is a good procedure to follow until such time as medical advice and treatment may be secured.

In graver injuries, where flying particles may have been driven into the eye tissues and injured the outer covering of the eyeball, it is wiser immediately to cleanse the outer surface of the eye, lashes and lids, place a wet dressing over the eye with a light bandage and secure forthwith medical opinion as to the best method of procedure.

The dirty habits, such as removal of things from the eye by utilizing a matchstick that has been carried in the smoker's pocket for a long while, have been largely discarded. In modern factories and mills nowadays instruction is given to employees in first aid, and, at convenient points throughout the plant, first-aid equipment stations are maintained with clean, sterilized materials such as are used in hospital operating rooms always available.

By closing the eyelids until a good flow of tears accumulates under them and then blowing the nostril hard on the side toward the eye in which the dirt is located, one may often wash the irritating bit of dirt down the nose.

It sometimes happens that an acid burn of the eye is sustained. It is safe immediately to wash the acid-burned area with an alkaline solution made by adding half a teaspoonful of ordinary baking soda (bicarbonate of soda) to half a glass of water, or, in the absence of water, one may put a little of the dry powder into the eye. Introduction of the powder may not be quite comfortable, but it will retard the deep burn and in most instances will be soothing.

Printed or typewritten instructions may be available, giving suggestions as to what may be done until a doctor can be secured. In all such first-aid efforts stick to the cardinal principles of cleanliness, doing no hurt and placing the eye at rest.

*Medical Director of the National Committee for the Prevention of Blindness.

EDITORIALS

F. R. LOW, *Editor*

The Power Show

THE 1927 New York Power Show is now a matter of history, but its visitors carried back to their normal pursuits many helpful ideas and certain impressions that must be appraised in retrospection. In the number of exhibitors this year's show exceeded last year's, and the attendance was somewhat larger. Moreover, the exhibits were in general better and more attractively arranged.

A considerable number of the exhibitors, most of them manufacturers of large equipment, have signified their intention to skip next year's show and come back again in 1929, the management having made this possible for those who had regarded every year too often but who heretofore felt it necessary to exhibit in order to hold their spaces.

This lends support to the proposal for holding the New York and the Chicago Shows in alternate years—a matter that has been under discussion by the exhibitors' committee for some time, and the ultimate answer to which lies in whether the individual manufacturers find it profitable to exhibit twice a year, yearly, or every two years.

Despite this action on the part of some exhibitors there is certain to be a Power Show in New York next year. In fact, many have already signed for space. The 1928 show is likely to be smaller and less comprehensive, or the vacant spaces may be taken up with products less closely allied with the power field.

Load Peaks and Anti-Friction Bearings

FLATTENING the peaks in the load curve is a worthy occupation. Each peak removed or decreased in height is a victory for the engineer and helps him in two ways. It makes it possible for him to operate his plant at a more nearly steady load and hence more economically. And it represents an achievement that demonstrates the engineer's capability and fitness for his work.

Load peaks are caused by many things; but primarily, in industrial plants, they are due to the starting of machines or operations. When the severity of the peak is the result of a number of machines being started at the same time, much can be done to reduce it by scheduling the operation of the machines so that the starting loads are staggered. But still the individual starting loads of each machine cause peaks, and these loads may be as much as several hundred times the running load, although, of course, such cases are extremes.

The problem, then, is to lessen the load required to start the machines. One effective way to do this is to give the bearings close attention and good maintenance and to be careful that the lubrication of these bearings is correct. But in many plants the greatest step toward cutting down starting loads that can be made is to install ball or roller bearings on the machines in place of existing bearings that may be worn out or of an obsolete type. With these anti-friction bearings the starting load is but little greater than the running load.

With this in mind it should be a comparatively simple matter for the power engineer to make a survey of the plant and determine where such bearing changes can be advantageously made. The saving from the elimination of load peaks that will result from these changes can then be figured. If this saving is an amount worth going after, which, of course, will depend upon the conditions in any particular plant, the facts should be brought to the attention of the management.

All this means that the power engineer will have to know what goes on outside the four walls of his plant. But then, he should know anyway. For that is the only way that he will ever be able to bring about many other improvements besides that in load characteristics here discussed.

Post-College Training for Engineers

THERE was a tendency a number of years ago for young engineers to drop their habits of intensive study as soon as they left college and took up practical work. In many cases they found no immediate application for advanced theory in the more or less elementary shop or office work to which they, as engineers, were assigned. Later on in their professional life these men have found themselves handicapped by the lack of some special knowledge that they could readily have acquired in the years directly after they left college. In the later years, added responsibilities, family cares and the loss of study habits make any efforts at self-development hard and exacting.

This attitude has, fortunately, been changing of late years. The work covered by present-day engineering

courses in colleges has become less specialized, and the field of engineering has in the meantime become so broad that the graduate now often feels that he must secure additional instruction in certain specialized courses or other branches of engineering after leaving college. Other engineering graduates desire to fit themselves for executive work and frequently take up courses in business, such as accounting and commercial law. Still others, in small groups feel the need of advanced special training along the same lines as their college courses.

With this apparent demand for training what facilities are available to the young graduate? In many of our large cities, night schools have been opened which offer courses of college grade in business, engineering and general culture. That these fill a distinct need, is evidenced by the constantly increasing enrollment of college graduates in these courses. Such night schools deserve and are entitled to the hearty support of the whole engineering profession, for they are doing work of the greatest value, often under severe handicaps.

There appears to be an increasing demand for graduate instruction that is available to those employed in industry. Several of our large corporations have developed plans for giving advanced instruction to selected groups of college graduates, but the advantages of these courses are limited to relatively few men. A few scattered attempts have been made by the night schools to give advanced work, and these have invariably been enthusiastically received. Must our colleges extend their efforts and offer post-graduate instruction to men in industry?

Much could be done in the night colleges of our large cities if better financial support were given to those colleges. Our college graduates should be encouraged to continue their studies, particularly along advanced lines, so that they can take advantage of the latest technical developments and can more readily adapt themselves to the changes in engineering methods and ideas of the coming years. This need of post college training is becoming increasingly pressing and, in the interests of continued progress, should be met.

Why Not Try a Little Co-Operation?

ENCROACHMENT by the federal government upon the powers of the states has been exciting considerable discussion. The line of demarkation between where the federal government should quit and where the states should begin is not always easily defined. But, from the attitude of some of the states it would appear that they wish to play a lone hand until they are in trouble and then earnestly desire Uncle Sam to come rushing to their assistance.

New York State has a canal that has developed into a white elephant. Two years ago an attempt was made to have the federal government take it and develop it into a ship canal, at an expenditure of nearly a billion dollars. The recent suggestion that the federal government bear eighty per cent of the cost of the proposed flood-control program on the Mississippi River and that the states benefited pay twenty per cent has been met by a storm of protest from these states. There may be just cause for these protests, nevertheless it looks like another one of those cases where, if a financial obligation is to be assumed, the states are willing to let the federal government shoulder the whole responsibility.

The administration of the Federal Water-Power Act has been looked upon in a number of states as an infringement of state rights. Authority exercised by the federal government over water power is on three separate bases: public lands; regulation of domestic and foreign commerce; and treaties with foreign countries. The second gives Congress control over all navigable waters and the power to determine the type of structures that may be erected in and over them. Where waterways are international, their use is subject to treaties between nations, and the only power in this country for making and enforcing such treaties is the federal government.

While the protests against encroachment by the federal government on state rights in water-power development are growing louder, the obligations in administering these by government agencies is becoming more involved. Many of these obligations, the federal authorities contend, should be assumed by the states, but in most cases the states have no established authority to assume such responsibility. Until they are in such a position, there seems to be little cause for complaint, so far as the Federal Water-Power Act is concerned. It might be well for some of those who represent the state to practice a little more co-operation with the federal government in the interest of the public and do a little less talking for effect to promote their own political ends.

Imagine the Savings!

IMAGINE what a difference it would make in the amount of power some plants use if the transmission belting received the same care in purchase and maintenance that the boilers or turbines do. Ninety per cent of the power applied to a shaft may be lost in the belting. The desirability of preventing this has so impressed one great manufacturing company that it employs a skilled engineer for belting purchase and maintenance alone.

Of course, it may be said that not everyone can afford to do what this great concern has done. And if an expert is not employed for the job, why, then whose concern is it? Certainly not the power engineer's! He only has to supply the power for the belts to waste.

And the plant management does not care about how much power is wasted, as long as the machinery runs. Oh, no! But just imagine the savings that could be made!

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Testing the Air Hoist

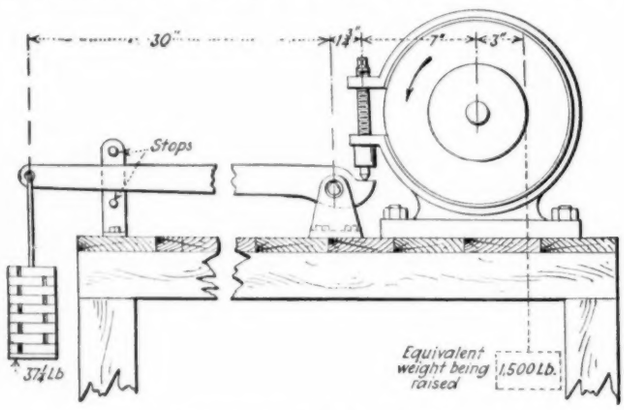
AIR hoists of various types are now used to considerable extent, and they are often expected to hoist more than they were designed for. To prevent this and to assist the repairman, the brake tester shown in the sketch was designed.

The brake band and the adjusting screw, belonging to the hoist, are swung around a quarter of a turn from the normal position, and the screw is fitted with an extension point to bear on the end of the lever.

With a pressure gage to show the air pressure at the time of the test, a test should be made when the hoist comes in for overhaul, and another test after the hoist has been repaired. The preliminary test will decide its condition and the probable amount of overhaul required.

To make the test, all that is necessary is to start the hoist with no load and adjust the brake and the weight on the end of the lever until the hoist indicates that the limit has been reached.

To find what each pound hung on the end of the lever is equivalent to in pounds raised by the hoist drum, all



Arrangement of air hoist tester

that is necessary is to know the ratio of the movements of the end of the lever to which the weight is attached, and a point on the drum periphery.

The ratio of the long and short ends of the lever is $30 \div 1.75 = 17.2$, and the ratio of the radius of the drum and the radius of the center line of the adjusting screw of the brake band is $7 \div 3 = 2.34$, and the combined ratio is $17.2 \times 2.34 = 40.24$ to 1.

One pound hung on the end of the lever will be equal to 40.24 lb. hung on the drum.

With $37\frac{1}{4}$ lb. hung on the end of the lever and the lever against the top stop, the hoist is then doing work equivalent to raising a load of 1,500 lb.

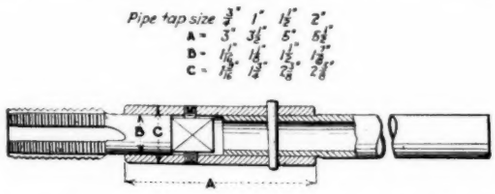
The brake horsepower generated will be the speed of the drum periphery in feet per minute, multiplied by 1,500 and divided by 33,000. E. J. JORDAN.

Long Beach, Calif.

Pipe Tap Guide

EVERY machinist knows how difficult it sometimes is to start a pipe tap and then keep it true. With a combined tap and drill it is comparatively easy, since the drill acts as a guide.

During the construction of steam power plants, mills, factories, etc., numerous holes have to be drilled and



Piece of pipe with sleeve forms guide for tap

tapped for thermometers, pressure gages and branch lines, ranging from $\frac{1}{8}$ to $2\frac{1}{2}$ inches.

A plan that I have found to work well is to provide each size tap with an extension, consisting of a sleeve and a piece of pipe as shown in the illustration. The sleeve is made from a piece of mild steel, bored to fit the shank of the tap. The sleeve is drilled and tapped to receive four safety setscrews, which are screwed in against the flats of the square on the tap. A piece of standard or extra-heavy pipe of suitable size is turned at one end to fit the other end of the sleeve and is secured by a taper pin. Up to and including $1\frac{1}{4}$-in. diameter pipe, I use extra-heavy pipe and above that standard-weight pipe.

The end of the sleeve that the pipe fits into, can be of such diameter as best suits the size of the pipe used without having to turn too much off the pipe.

The dimensions of some of the tap sleeves are given on the drawing. The length of the pipe can be about a foot for the smallest sizes, up to three or four feet for the larger ones. The tap is turned by applying pipe tongs to the pipe. Ordinarily, the tap will be guided by hand, but for accuracy a fixed guide can be provided for the pipe to turn in.

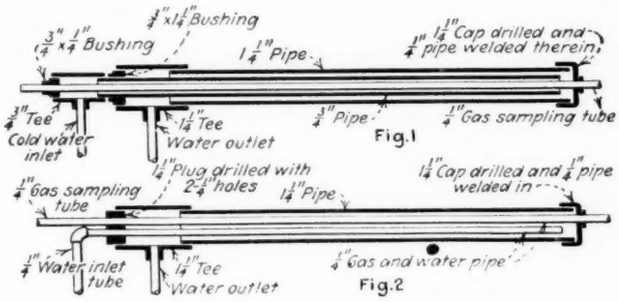
This combination will be found particularly useful when a hole in a hot pipe has to be tapped. In all cases where it can be applied, the job of tapping is made surprisingly easy. J. J. EDWARDS.

Long Beach, Calif.

Gas Sampling Tubes for Boiler Furnaces

IT IS well known that gas samples taken from hot furnaces, particularly where the sampling pipe gets red hot, are liable to considerable error, due to reactions taking place between the gases and the hot metal.

To avoid this, water-cooled tubes should be used, which



Figs. 1 and 2—Practical types of gas sampling tubes

circulate sufficient water to keep the temperature of the sampling tube comparatively low.

I have used several forms of water-cooled tubes, and I have found the types illustrated to be the most practical.

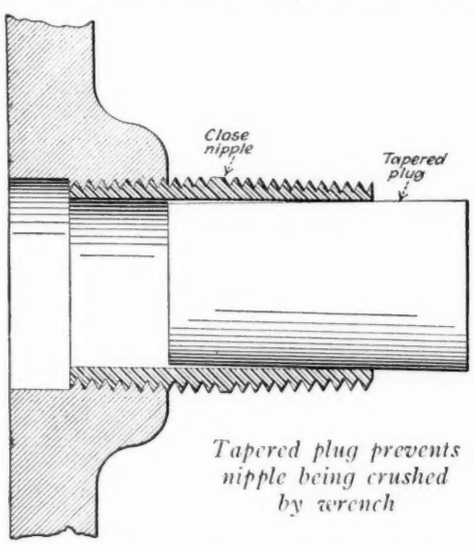
The type shown in Fig. 1 gives a uniformly cool tube and rigid construction; Fig. 2 has a floating tube for the water inlet but it is not as well constructed.

Dayton, Ohio. FRED EMMARD.

Easy Way to Remove Close Nipples

NOT infrequently, when one attempts to remove a close nipple from a heater, pump or other piece of power-plant machinery, it is found rusted in tight, and when the pipe wrench is used, the nipple is crushed and broken off, making it necessary to remove the broken end with a hammer and chisel.

After I had had a few such experiences, I made a set



Tapered plug prevents nipple being crushed by wrench

of tapered steel plugs like the one shown in illustration, one for each size of pipe. Simply drive the proper size of plug into the open end of the nipple; this will prevent the wrench from crushing it and breaking it off.

South Acton, Mass. C. F. HAMILTON.

Setting the Integrator After Repairing

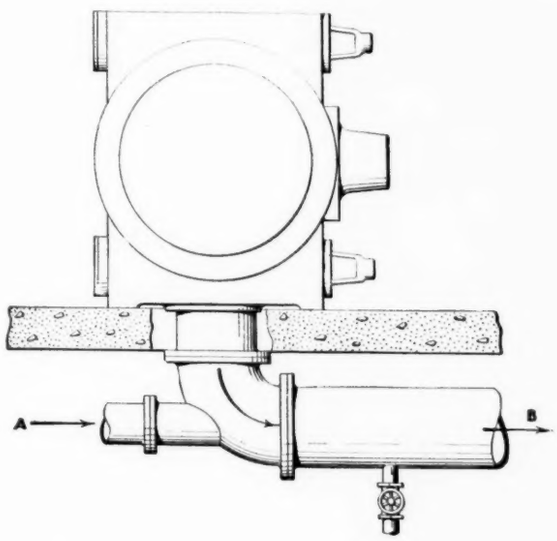
WHILE checking the integrator on one of our Venturi meters, the hands did not pass the figures the way they should, so the six hands were soldered on the spindles with all hands on zero. As the reading had to be the same as when taken off, it was necessary to rotate the gears until the dials registered 6,458,315.

As it would take considerable turning by hand to get this reading, I took the integrator down to the machine shop and held the point of the driving spindle in the counterbore in the end of the emery-wheel shaft. In this way the hands of the integrator were rotated to the proper reading in about twenty minutes, whereas, if it had been done by hand, it would have taken several hours. T. J. CULHANE.

Middletown, Pa.

How the Back Pressure Was Reduced

IT MAY be of interest to readers of *Power* to learn how back pressure was taken from an engine accidentally. In our plant large amounts of low-pressure steam are used, 150,000 lb. per hour or even more.



Reduced-pressure live steam is admitted to the engine exhaust

When extracting from some turbines and taking all the exhaust from other turbines and reciprocating units, it is necessary at times to boost into the line with high-pressure steam controlled by reducing valves.

The illustration will indicate how one reducing valve discharging into the exhaust tee acts as an ejector. It was found from indicator diagrams that it actually reduced the back pressure on the engine four pounds. The highest back pressure is eight pounds.

The next step will be to supply the same system to the extraction lines to get more low-pressure and less high-pressure steam.

New York City. C. W. PETERS.

COMMENTS *from* READERS

How Would You Do It?

THE question How Would You Do It? by M. E. Wagner in Oct. 11 issue, page 555, brings to my mind some past experiences. Several years ago I was engaged in erecting small Diesel engines in southern Texas, and on one occasion the engine was erected and ready to start before the auxiliary compressor had arrived. After exhausting several husky helpers trying to crank the engine by hand, one of the men suggested using steam from a near-by boiler, which proved a success, and I suggest Mr. Wagner consider this method.

Although he does not state the size and make of the engine, it is possible that steam can be used on the starting cylinder, which is equipped with an automatic starting valve to admit the steam into the cylinder, the same as the air supply. If the engine is single-cylinder, it is possible to start it and run by steam up to speed, then synchronize with the steam-driven unit, then cut the steam off the Diesel and turn on the fuel. The unit then will be operating as a motor until the engine starts to function.

W. R. PENDER.

Ancon, Canal Zone.

* * * *

How to Cut Gage Glasses

IN THE Oct. 18 issue an engineer disagrees with the answer to question No. 9 in the Aug. 23 issue on how to cut gage glasses. The point of contention is that it is not necessary to file a notch all the way around the glass, a $\frac{3}{16}$- or $\frac{1}{4}$-in. notch being sufficient, the breaking being done by bending the glass between the fingers. Of course this method is usually employed in cutting ordinary glass, and it works. Physicists and chemists sometimes employ this means of cutting rather heavy tubing. They make a partial scratch and apply a small red-hot tube to the scratch, then they moisten the spot where the hot tube was applied, and the tube breaks.

In my attempts to cut Pyrex tubing, I tried the two methods mentioned, with no success. A partial scratch and bending gave a jagged, slivery break, with cracks running longitudinally down the tube. I found this method extremely risky in the chance I took to cut my hands. Then I tried the local hot tube heating with no success. The tube did not even break. Then I filed the notch all the way around, and heated the section, with the results as described in the Aug. 23 issue. Then the electric method was tried, which gave good results.

Pyrex tubing is difficult to cut because the glass is hard and brittle—much more so than ordinary glass. In addition it has an extremely low coefficient of expansion. For this reason local heating, which is effective in breaking ordinary tubing, is ineffective with Pyrex tubing. The heating must be intense, concentrated in a narrow band, in order to realize the difference in the coefficient of expansion for a complete break. The electric wire method does this. It heats the glass in a very narrow band to a rather high temperature, which gives sufficient expansion for a break when a drop of water is applied, producing a sudden contraction. Once the break starts at a point, it naturally follows the path of least resistance, which is the place where the tube was heated by the wire.

State College, Pa. A. J. NICHOLAS.

* * * *

"What Do You Know?"

WITH reference to question No. 6 on page 659 of the Nov. 1 issue, Could you operate a steam turbine after two rows of blading had been destroyed? The answer is given as "yes" on page 674. For fear someone might go astray, I think this should be more completely answered.

Many turbines have but one row of blades or buckets. Some have two rows and others have ten or more. This question evidently refers to a turbine with many rows of blades, and it is this type that the question should explain more fully.

When a row of blades is damaged, the disturbance usually starts in a moving row. Parts of blades are therefore thrown around, battering up other blades and closing up the steam space in the other rows. This will reduce the capacity and in some turbines will cause excessive end thrust. Sometimes, only a part of a rotating row breaks off. This, of course, will result in vibration from unbalance. The answer should therefore be clearly understood to include that the entire row should be cut off in each row appreciably damaged.

WEBSTER TALLMADGE, *President*,

New York City. Webster Tallmadge & Co., Inc.

* * * *

The Smoke Nuisance

THE "Foreword" in the Nov. 8 issue on "The Smoke Nuisance" is timely and to the point. The statement is made that "it is in the main preventable," but the question is, How is it preventable? In most cases where there are smoking chimneys, the primary causes are, in my opinion, ignorance, carelessness and inability.

We will say an engineer accepts a new position with a company. He finds the boilers and furnaces in poor condition, resulting in imperfect combustion and a smoky chimney. He makes a few suggestions to the Chief (who has been there a long time) and gets no satisfaction. He then tries the fireman, who, being used to the old order of things, says he will not change his method of firing for the small amount of money he gets.

There is only one way, it seems to me, to abolish the smoke nuisance and that is by law. I mean by that, a law (where there is not already one) prohibiting smoking chimneys, one that is rigidly enforced and a severe penalty given for violating it. I know of cities that have

such laws and they are not properly enforced. When this is done, correctly designed furnaces, tight boiler settings, and engineers and firemen who care, will be the rule rather than the exception. FRED. E. BOND.

Louisville, Ky.

* * * *

What Makes the Boiler Drum?

REFERRING to the query of H. M. Toombs in the Nov. 8 issue, "What Makes the Boiler Drum?", this condition is not experienced often in stationary plants, but is common enough in marine boilers and more so where oil is used as a fuel.

The noise is deep, gutteral and continuous; vibration takes place, shaking bricks from the walls, cracking and loosening arches and other parts.

This trouble is caused by improper combustion, and as one of the essential parts of combustion is that the mixtures of distilled gases and air must be maintained at a temperature of incandescence in order that the gases may be burned before they become cooled below the ignition temperature by contact with the heating surfaces, it is apparent that by allowing "thin" spots in the coal bed, proper combustion is not permitted. The air passes through these spots too quickly, preventing proper combustion in other parts of the fuel bed, resulting in a series of explosions; hence, the noises and vibration. The coal should be kept at a uniform thickness on the grates.

In oil-fired boilers conditions are somewhat different, yet poor combustion is the cause. Improper mixture of oil and insufficient air does not permit the thorough burning of the oil, and a boiler will shake, pant, hum and vibrate. Sometimes, from observation, the combustion appears perfect, yet the boiler will vibrate. The causes in such cases are due to design of burners and size of cones, whereby the air is restricted from properly mixing with the oil. In such cases it is found necessary to adjust the burners by setting them in farther and enlarging the radius of the cones.

I have had considerable boiler experience both ashore and afloat and have found in most cases that the majority of troubles are due to poor combustion.

ERLE S. NASON,
Boston, Mass. Chief Machinist, U. S. Navy.

REFERRING to H. M. Toombs' letter in the Nov. 8 issue, I once operated a temporary plant that had two boilers that drummed badly. They were 2,500-sq.ft. units equipped with hand-fired shaking grates. I do not doubt Mr. Toomb's statement that the phenomenon has driven a deaf man out of the boiler room, because it is certainly nerve racking.

Undoubtedly, it is caused by gases generated in the fuel bed burning in a series of explosions which maintain a condition of resonance in the closed combustion chamber. In my case it could be stopped by leaving the firing doors partly open, which, as it happened, was not objectionable because the air was needed above the fuel bed.

I noticed also that the drumming was not much in evidence when coal not larger than nut size was fired. A mixture consisting of egg size with nut and slack would cause drumming almost impossible to stop. It made little difference whether we fired light or heavy. The drumming was worse just after throwing in fresh coal.

It seems clear that the resonance condition is affected by the size of the combustion space, probably also by the size and length of the gas passages. In other words, it is a condition that is built into the boiler setting and breeching, and may be difficult to remedy. Possibly changing the baffles might have some effect, maybe only to change the tune, or number of vibrations per minute. If it is practicable to increase or decrease the size or the volume of the closed space above the fuel bed, the resonance might be broken up.

All the drumming boilers I have seen have had natural draft. I have never heard a forced-draft stoker-fired boiler drum. If Mr. Toombs has occasion to apply force or induced draft to his boilers, the drumming might be stopped by the change in fuel-bed conditions.

Locomotive boilers drum occasionally, but apparently it is only when there is no induced draft from the engine exhaust or steam blower. J. H. DAYDEN.

Charleston, W. Va.

* * * *

Recompression and High Temperatures of Air

In relation to air compressors and overheating one often hears the expression "recompression." This implies that a certain amount of air is subjected to compression, and in some way is subjected to subsequent expansions and compressions in the compressor cylinder.

The compression of air is accompanied by a rise in temperature according to a well-known law. In normal compressor operation this temperature may rise to 200 or 300 deg. above the temperature of the air intake. At times it may rise a great deal higher, owing to some abnormal conditions arising within the compressor itself.

Recompression of some of the air compressed, and therefore heated, is offered as the cause of some of these extremely high temperatures. In fact, it is claimed that the discharge valves may even become so hot as to be what is termed "red hot."

There are two ways in which air may be recompressed. One of these is through leakage back into the cylinder via the discharge valve. Another way is through leakage past the piston rings in double-acting machines, thus causing an increase in temperature of the suction air on that side of the piston.

The first mentioned idea of air leading back through the discharge valve is explained thus: The air being compressed in the cylinder and discharged, is heated to perhaps 300 deg. F. Being passed only into the discharge passage, little if any cooling takes place. Should the discharge valve be defective in any way, this uncooled compressed air expands back into the compressor cylinder, raising the temperature of the air therein and actually preventing much of the suction air being drawn into the cylinder. The leakage may take place even after the compression stroke is well started.

On the next stroke this air, with an initial temperature higher than it was on the previous stroke when the cylinder was filled with air at atmospheric temperature, is compressed and a higher temperature results at the final compression pressure than was the case with the previous stroke. Now, some of this air already "recompressed"

and at a higher temperature, leaks back into the cylinder and the compression is started at a still higher temperature than on the preceding stroke. This process goes on until the compressor and the discharge valve become quite hot.

It is sometimes maintained that the same effect is obtained by leakage past the piston rings, but the conditions here are quite different from those where leakage occurs through a discharge valve.

In the first place, the piston rings must be in fair condition if the compressor is to compress to a given pressure and discharge a quantity of air. In the second place, the piston rings are subjected to high pressure during a small fraction of the stroke so that leakage past the rings can only be for, perhaps, a quarter of the length of the stroke.

In the third place, air leaking past the piston rings would be reduced in temperature by its contact with the cylinder walls, which are cooled by the water jacket and consequently have a moderate inside surface temperature. Any air, therefore, leaking past the piston rings would be cooled and the temperature of the suction air for compression, though increased slightly, would soon reach a limit due to the cooling effect. An equilibrium would thus be established, which would preclude the possibility of danger in compressor operation arising from recompression as applied to the leakage past the piston rings that are not tight.

Recompression through the discharge valve leakage may be thus compared to piston leakage recompression: (1) There is no cooling effect as the air passes over the discharge valve that has already been heated by the heat of compression; (2) there is a possibility of leakage during the entire suction stroke and part of the compression stroke and even of the prevention of the compressor taking in any or much atmospheric air; (3) the discharge valve is subject to accumulation of heat because of its lack of cooling and because of the constant flow of heated air past it.

With piston leakage: (1) The expanding air is cooled by its passage adjacent to the water-cooled cylinder walls; (2) leakage is possible only during a small portion of the suction stroke; (3) in the event of leakage a temperature equilibrium is soon established at a moderate temperature.

It would therefore seem that the recompression of air can be considered only as applied to a leaky discharge valve and not to compression resulting from leakage past the piston rings in a double-acting compressor.

Scarsdale, N. Y. WILLIAM V. FITZGERALD.

* * * *

Treating Evaporator Feed

The article in the Oct. 11 issue by Captain H. C. Dinger, on "Treating Evaporator Feed," has been called to my attention, and I should like to describe the method I have been using successfully for the elimination of scale formation in evaporators.

Scale removal by "cracking" has not proved entirely satisfactory, nor has the chemical treatment of evaporators met with much favor, owing I believe to the use of "compounds" that contained ingredients unnecessary for scale removal and owing to improper control of the treatment by chemical analyses. One of the chief difficulties with the chemical treatment was the priming of the evaporators. This can be overcome and scale formation eliminated if the proper chemicals are used and frequent checks made on the water to ascertain if the proper amounts of the various chemicals are being used to treat the water.

I have found that the best results can be obtained through the use of liquid sodium aluminate either alone or in conjunction with caustic soda or soda ash. The sodium aluminate serves for two purposes: First, it acts as a softening reagent, and second, as a coagulent. I have found that good coagulation can be obtained by using $\frac{1}{4}$ lb. of the liquid sodium aluminate per 1,000 gal. of water evaporated. If necessary, sufficient caustic soda or soda ash, depending upon the analysis of the raw water, is then added to soften the water in the evaporators completely. By obtaining coagulation in the evaporators, the finely divided suspended matter is coagulated, the total number of particles in the water reduced and priming prevented.

The water from the evaporators is tested daily for hardness, alkalinity and causticity, and the treatment is regulated by these tests. Also, daily tests are made on the boiler water for hardness, alkalinity and causticity. This is to determine whether there has been any priming in the evaporators. One plant that I know of in particular, controls the alkalinity in the evaporators so that they get just sufficient priming to produce an alkalinity in the boiler water which will inhibit corrosion. By running daily tests on the evaporator water and the boiler water, they can control this amount of priming so that they have entirely eliminated corrosion that occurred without such control.

The treatment is added directly to the evaporators in slugs, depending upon the rate at which the evaporators are run. If the evaporators are not overtaxed, the entire treatment for the 24 hours can be slugged in at once, blowing the evaporators down thoroughly just before adding the treatment. However, if the evaporators are worked hard, the treatment should be divided into three equal doses daily, blowing the evaporators down just before adding each treatment.

An extract from a letter received from one plant using the foregoing method states: "Before the start of your operation in this plant the evaporators after two months' run built up considerable scale. So much so that it required 37 lb. of steam with a resulting 17-in. vacuum to evaporate sufficient water for the boiler after a 30-day period of operation. With a treatment of $\frac{1}{4}$ lb. per 1,000 gal. of No. 2 sodium aluminate, it was found that 25 lb. of steam with only an 8-in. vacuum was necessary to supply the requirements. With this treatment the evaporators were run for two months and when opened were found to be not only clean, but practically spotless, and no trouble whatever has been experienced in keeping them so."

With regard to treating sea water by this method I have not had any actual experience, and it is possible that the different conditions experienced in evaporators on vessels would bring up complications not foreseen in this method.

However, I feel that with careful chemical control and the use of the proper chemical, results can also be obtained with sea water. J. A. HOLMES,

Chicago, Ill. Chicago Chemical Co.

Competitive Purchasing and Evaluation of Proposals for Power Plant Equipment

IN EXTENDING power plants and building new ones, engineers strive to obtain the best possible results, taking into account both first cost and operating costs. After the general plan of design has been decided upon, perhaps the most important factor in its

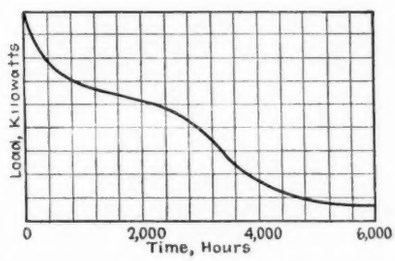


Fig. 1—Annual load-duration curve

bearing on final results is the selection between different makes of the individual pieces of equipment that together make up the power plant.

This company's process of purchasing competitively interweaves through the purchasing and engineering departments and may perhaps be divided into four parts:

1. The specifications prepared by the engineers.
2. The obtaining of proposals under these specifications by the purchasing department.
3. The evaluation of the proposals through the co-operation of both departments.
4. The final closing of the purchase.

The specifications are intended primarily to describe the operating results to be obtained, leaving just as wide open as possible to the judgment of the bidder the detailed methods by which this result is to be accomplished. The specifications are then submitted by the purchasing department to the manufacturers for proposals, with the request that these proposals be separated into two parts: First, the complete engineering proposal including all performance guarantees as required by the specification, dimensions and descriptive material for use to form judgment as to the adequacy of the proposal; a second part covering price and shipment of the material described in the first half of the proposal.

It has been the experience of this company that if judgment is first formed of the relative advantages of different propositions from the engineering data only, without the price, the advantages and disadvantages other than those expressed in the actual performance guarantees, can be weighed with more freedom from prejudice. The process of asking one's self how much more in dollars one proposition is worth than another is conducive to careful thought to make certain that one's opinions have a sound basis of fact.

It is believed to be sound policy in comparing propositions to take the performance guarantees of reputable manufacturers at their face value without any corrections for probable differing margins of safety which may be claimed. If a manufacturer desires to make a certain guarantee and then asserts that he has an extra large factor of safety, one is compelled to believe either that the factor of safety is mostly in the salesman's talk, or that the company submitting the proposal has not the courage of its convictions. It is expected that all equipment will be tested after installation and that the material, when installed, shall either meet guarantees or be corrected by the manufacturer until it does come up to guaranteed performance.

AT A meeting of the Metropolitan Section of the A.S.M.E. held a few weeks ago at the Brooklyn Edison Company auditorium, two papers were presented, one by L. B. Bonnett, purchasing agent of the Brooklyn Edison Company, in which he described the purchasing policy of that company, and a companion paper by J. N. Landis, plant equipment engineer, in which paper was described a method of engineering analysis as applied to the selection of power plant equipment.

Because of the inexactness of the promise extreme accuracy in arriving at the annual and capitalized operating costs is unnecessary. It frequently happens that the obviously most efficient or most suitable machine is also the lowest in first cost, and after a preliminary inspection of the proposals a conference between the engineering and purchasing departments will settle the choice without question. In other cases where there are several bids, such a conference may show that some of the bids are obviously out of the running because of comparatively poor performance often coupled, strangely enough, with high price. With these eliminated, the remaining proposals become a subject of mathematical study of operating costs in a manner described in the companion paper. The results of such analysis indicate the capitalized advantage of one proposition over another due to better performance.

There are often minor factors of preference against which it would be almost impossible to assess a definite value, but an expression can quite properly be made of an unevaluated preference, other things being equal. This would have a very important bearing on the placing of the business if the prices as weighted by the evaluation factors are very close together.

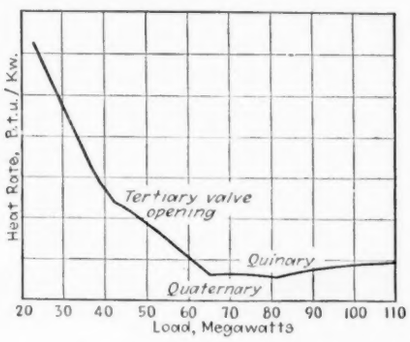


Fig. 2—Turbine heat rate

When the performance calculations have been completed, the results are gone over in conference between those responsible for operation, engineering and purchasing, and final figures are agreed upon showing the comparative

value to the company of the different propositions under consideration. They are conveniently expressed as excess charges against certain proposals.

The purchasing department then takes the quoted prices and adding the evaluation charges, arrives at a weighted figure of cost.

Considering also, matters of purchasing policy, such as the dependability of promises of shipment, the time required for manufacture, the reputation of the manufacturer for fairness in taking care of minor changes, and the encouragement of active competition, the proper disposition of the order becomes at once apparent. It is felt that this procedure has the definite effect of encouraging the manufacturers to propose the best equipment they know how to build. It clearly indicates that excellence of performance has a definite and recognized value to us. This method, it is believed, results in the fairest judgment of the merits of different proposals and therefore results in the purchase of the most satisfactory equipment for the physical conditions that have to be met.

Engineering Analysis Applied to the Selection of Equipment

An abstract of the companion paper by Mr. Landis follows.

With the great increase in the variety of kinds and sizes of equipment that can be purchased, it becomes necessary, as a guide to anything but perfectly arbitrary engineering and purchasing, to develop an analytical engineering and economic basis for settlement of questions relating to type, size and make of equipment. In order to describe the method of analysis as developed in connection with Brooklyn Edison Company Engineering, a single illustrated example will be discussed.

The evaluation of annual operating costs and carrying charges for a particular turbine and steam generating

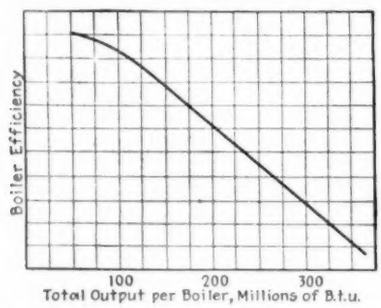


Fig. 3—Efficiency of steam generating equipment

equipment, for which guarantees will be assumed to be in hand, is chosen to serve as such an example.

The obvious starting point is with the daily load curves for some known year of the unit's operation. If these curves are redrawn without reference to the time sequence of machine loading, the resulting curve is called a load-duration curve. Combining 365 successive daily load-duration curves, or a lesser number of properly weighted "typical" daily load-duration curves, an annual load-duration curve is obtained, as shown in Fig. 1.

The turbine proposal will contain a turbine heat-rate curve, such as shown in Fig. 2. It indicates the amount of heat consumed by the turbine per kilowatt at each load. The steam generator proposal will contain an efficiency curve, Fig. 3, showing the ratio of output to input for the fuel burning equipment, boiler, and economizer or air preheater.

By multiplying the ordinates of the turbine heat-rate curves shown in Fig. 2, by the respective abscissas, there result values from which a turbine input-output curve can be plotted as shown in Fig. 4. If, for particular values of heat required by the turbine to produce certain loads, the corresponding boiler efficiency is obtained and divided into the turbine heat requirement, the result represents the boiler input necessary to generate the required heat for the turbine or the assumed turbine load. Continuing this process for the entire tur-

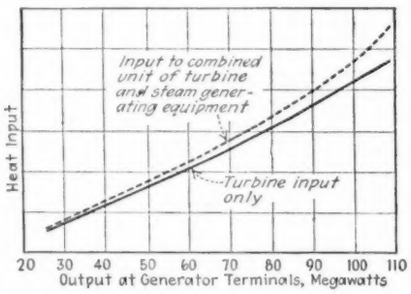


Fig. 4—Input-output curve for complete unit

bine load range, the dash line curve shown in Fig. 4 can be obtained and represents the relation between boiler input and turbine output.

With this input-output relationship for the steam generation equipment and turbine in mind, it will be seen that for each particular value of load in the duration curve it is possible to substitute the corresponding heat input to the steam generating equipment. This process will result in a B.t.u.-input duration-curve which is shown in Fig. 5. Since the ordinates of this curve are B.t.u. per hour and the abscissas are hours of duration per year, the area under the curve represents the total heat consumption of the combined equipment for the year considered. This value may be used to obtain the pounds of coal per year if the average heat content of the coal used is known.

It is well recognized that as equipment ages its load is decreased. Thus it is necessary to apply to the annual coal consumption a factor which might be termed the "used expectancy factor," in order to compensate for this condition.

After the effective average coal consumption has been derived, the operating cost may be determined by applying the average coal cost expected over the operating life of the equipment.

For the purpose of direct comparison with investment cost, annual operating costs may be capitalized by dividing them by the annual carrying charge rate. This rate, as is well known, includes

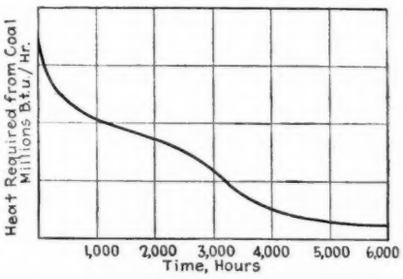


Fig. 5—Heat-requirement-duration curves

interest, taxes, insurance and amortization. In addition, it is believed the total carrying charge rate should contain an "incentive" rate factor by which is meant that margin of safety justly applicable to investment in expensive or in new and untried apparatus.

The capitalized coal consumption added to the investment cost will, in all normal cases, represent the major part of the total charge assignable to a group of equipment under consideration. In general, there will usually be certain other favorable or unfavorable factors to be considered in an equipment evaluation. Falling in this classification of items may be such matters as floor space occupied, maintenance, or other alluring possibilities the true merit of which it may be desired to ascertain before starting the construction of a new station. The assignment of values to these factors may be either rational or arbitrary, and no generalization as to valuation methods can be made.

The summation of the capitalized coal cost, the investment cost, and all additional evaluations made will result in a single money value representing a charge against any one kind of development or equipment. If for several developments or equipments this same general process is followed, careful attention being paid to securing a commonness of procedure in all the separate analyses, the results may be compared. This process constitutes a general procedure which can be applied to the bulk of engineering problems.

The paper continues with a more detailed discussion of some of the items that are necessary to the general procedure, such as the development of the load duration curves expected performance data and installation costs.

A method was also given for determining the most economical size of equipment in combinations such as boiler, economizer and air preheater.

NEWS *of the* FIELD

Power Transmission Association Holds Annual Meeting

Presents Statistics Showing Place of Mechanical Drive in Industry and Announces Program of Research and Further Co-operation With Manufacturers

THE significance of mechanical drive as a dominant factor in industrial production was well brought out at the Annual Meeting of the Power Transmission Association, held at the Hotel Commodore, New York City, on Dec. 11. This association, it will be recalled, was formed last year, "To promote the most efficient and economical distribution of power; to make a scientific study of all engineering problems connected with the transmission of power; to accumulate and compile and to co-ordinate accurate and authoritative information regarding the most economical and efficient power transmitting methods, and to place this information at the disposal of all power users through the members of this organization and through planned publicity; to further the interests of affiliated manufacturers and their distributors making and handling power equipment."

Membership in the association is made up of over one hundred manufacturers of mechanical drives, pulleys, belting, etc. In addition there is an Advisory Committee of twenty power transmission engineers representing the major industries, who have laid out a comprehensive program covering investigation and study of problems connected with power drives, compilation of test data and the publication of a handbook.

Adopts "Drive Right" Slogan

At the morning session, which was largely devoted to business of the association, an emblem and slogan were adopted. The latter is very effectively named "Drive Right." It was brought out that present-day driving practice in industrial plants shows approximately:

Belt drives	88 per cent
Direct drives	5 per cent
Chain drives	4 per cent
Gear	2 per cent
Rope and other types	1 per cent

Furthermore, it was stated that in the metal-working industry 22 per cent of the investment is in machinery, 5 per cent in the power plant and 3.36 per cent in power transmission. In the latter figure power feed wiring represents 1.3 per cent, motors 1.1 per cent, lineshafts 0.5 per cent, pulleys 1.6 per cent and belting 0.3 per cent.

At the afternoon session, following the luncheon, President Fisher introduced W. L. Batt, president of the SKF Industries, who gave some sound advice on policies, which, if followed, would steer the association along a successful path. In this he urged facing and sticking to the facts, also that the scope of the association be extended to include all factors that its name implies. He called attention to the present tendency toward the formation of a multiplicity of associations and societies and expressed the belief that there would be a tendency to cut down this number. Those that are founded on the proper lines and doing real constructive work would survive. He was followed by R. T. Kent, who made a plea for further research in power transmission and extended a cordial co-operation from the professional divisions of the American Society of Mechanical Engineers.

W. H. Rastall followed with a talk on certain activities of the Bureau of Foreign and Domestic Commerce, Department of Commerce. This bureau has expanded thirty-eight times since it was established in 1912. Up to the present time the development has largely centered in foreign trade, but attention is now being given to domestic commerce. The speaker urged that the machinery industry of the country offer suggestions and help in promoting this phase of the work.

Importance of Belt Selection

William Staniar, belting and transmission engineer of the E. I. du Pont De Nemours & Company, who is Chairman of the Board of Advisory Engineers of the Association, presented a paper in which he said that as a rule executives neglect their belting, while employing trained men for the mechanical power generation and electric transmission within their works. As a result of this there are many poorly designed power drives in industry and there is a broad opportunity for corrective measures in this line. The purchase, installation and care of belting and other means of power transmission cannot be left to untrained men. The use of the right belt in the right place as to type, width, thickness, speed and material, to meet operating conditions, is all important. Moreover, accurate records of belt performance are a necessity. In this connection the speaker told of the extremely hard operating conditions to which certain belts are subjected in his own company. An intelligent study in selection had led to measuring the life of belts in months rather than in weeks.

Mr. Staniar pointed out that power belting is holding its own in spite of electric drive. For instance, in the plants of the General Motors Company, 85 per cent of the drivers are on the group system.

The program of the Board of Advisory Engineers was next announced. This includes:

1. The collection of information on the relative economies of direct and group drive.
2. Care, lubrication and maintenance of mechanical transmission equipment.
3. Test data.
4. A study of the best methods of using transmission equipment to avoid mechanical losses.
5. Employment of expert engineers for this purpose.
6. Further development of testing apparatus.
7. A listing of the types of transmission equipment used in the more important industries.
8. Further studies to promote standardardization and simplification.
9. The compilation of a power transmission handbook.

It was further urged by the Advisory Board that the American Society of Mechanical Engineers create a section of its power division devoted to power transmission.

Unit of 40,000 Hp. Added to Norfolk, Va., Plant

A new addition to the Reeves Avenue power station of the Virginia Electric & Power Company, at Norfolk, Va., was formally opened the afternoon of Dec. 7.

Special ceremonies were held for the dedication of the addition, which virtually doubles its capacity. William E. Wood, president, J. Frank McLaughlin, vice-president and several other officials attended.

A new 40,000-hp. turbine generator has been installed in the addition. Transmission lines link this plant with Richmond, Petersburg, Fredericksburg, and Roanoke Rapids, N. C., affording electric power throughout that section of Virginia and northeastern North Carolina. The additional power furnished by the plant will be available to Richmond industries, it was stated. The new unit was installed at the cost of $5,000,000.

Large Plant Planned for 1929 May Use 1,200 Lb. Pressure

Construction of a new power station to operate at 1,200 lb. pressure, and to be known as the "Deep Water Station" to supply power for the Atlantic City Electric Company and the Delaware Electric Power Company, is being planned for completion about the close of 1929.

The plant will be on the Jersey side of the Delaware River at Deep Water Point, opposite Wilmington, Del. It will be projected for an ultimate capacity of about 400,000 kw., it being probable that the initial installation will consist of two units, each approximately 50,000 kw. In designing this plant, consideration is being given to the use of 1,200-lb. boiler pressure. It is expected that the station will be available for initial commercial service in two years.

This newcomer to the ranks of high-pressure stations will be jointly owned by the American Gas & Electric Company and by the American Electric Power Corporation. It will supply power for the Atlantic City Electric Company and the Delaware Electric Power Company, formerly the Wilmington & Philadelphia Traction Company, which are subsidiary companies to the holding companies first mentioned.

Stevens & Wood, Inc., engineers and constructors, 120 Broadway, New York City, announce that they have signed a contract covering its design and construction.

Guercken Finds Europe Fast Progressing Electrically

Great progress in electrical development is being made throughout Europe, with the result new records are being established in many of the continental nations, according to P. Guercken, European manager for the Westinghouse Electric International Company, who is visiting in New York City.

"Norway is now the world's largest consumer of electrical energy," Mr. Guercken said.

"Italy, a pioneer in railway electrification, now stands in the lead in the number of miles of electrified railways.

"Interconnection of power distributing systems is playing an important part both in Spain and Great Britain," Mr. Guercken said. "A great superpower plan has been developed in England."

Correction

In a news item reporting the sale of the Kewanee Boiler Company's plant, Kewanee, Ill., to the American Radiator Company, printed in the Nov. 1 issue, an erroneous statement by a correspondent that "the riveting system used in the Kewanee plant will be superseded by a steel welding process" appeared. *Power* wishes to call attention to the fact that there is no intention of superseding the Kewanee practice of riveting steel boilers by any other method for joining steel plates.

"1927 Business Satisfactory, Outlook Favorable"—Swope

"The electrical manufacturing business for 1927 has, on the whole, been satisfactory, and about the same in volume as the previous year," according to Gerard Swope, president of the General Electric Company, reviewing conditions for the past year and commenting on the outlook for 1928. "The use of electric current in homes and factories has increased 7 per cent over 1926, and with the exception of 1921 has shown an increase each year since 1919, when the index was first prepared, and the consumption in 1927 was more than double what it was in 1919. This is becoming one of the best indices of general and industrial conditions in America.

"The outlook for 1928 is, on the whole, favorable. Economic conditions are sound and the satisfaction of the demand of 120,000,000 people should provide ample business activities with the usual attendant improvement in the art. Earnings of labor have never been so high, and with a continuance of good business their earnings should continue and employment become steadier."

Next I.E.C. Plenary Meeting in Scandinavia, 1930

The next plenary meeting of the International Electrical Commission will take place in Scandinavia in 1930, according to a report that the joint invitation of Denmark, Norway and Sweden has been accepted by the council of the Commission.

The Belgian Committee has also invited the Commission to meet in Brussels in that year, but, owing to the priority of the Scandinavian invitation, it was declined, with the hope, however, that some future plenary meeting will be held in Brussels.

Societies Present Holland Tube Scrolls

IN ACKNOWLEDGMENT of the tributes paid by the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission to the engineers of the Holland Vehicular Tunnel, the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers presented each of the two tunnel commissions with a parchment scroll as a permanent record of appreciation, at simple exercises Dec. 13.

Col. Willard T. Chevalier, general manager of *Engineering News-Record* and a member of the board of direction of the American Society of Civil Engineers, made the presentation address for the four societies in the offices of the commissions at Canal and Vestry Streets. Theodore Boettger, chairman of the New Jersey Commission, and Gen. George R. Ryan, chairman of the New York Commission, accepted the scrolls for their respective commissions.

The scroll, elaborately illuminated and headed by the names of the four societies and the date of the completion of the project, is reproduced herewith.

American Society of Civil Engineers
American Institute of Mining and Metallurgical Engineers
American Society of Mechanical Engineers
American Institute of Electrical Engineers

New York
November 16th, 1927.

Appreciating the Tributes paid to the Skill and Devoted Service of

Clifford M. Holland
Milton H. Freeman
and Ole Singstad

Chief Engineers of the Holland Vehicular Tunnel,
and to their engineering assistants,

upon the occasion of the formal opening of the Tunnel on November fourteenth, nineteen hundred and twenty-seven and especially appreciating the naming of the Tunnel after Mr. Holland and the East Plaza after Mr. Freeman, the Executive Officers of the above named National Engineering Societies, in behalf of the membership of these societies, some fifty-seven thousand in number, hereby express in turn their appreciation to the members of

The New York State Bridge and Tunnel Commission
and
The New Jersey Interstate Bridge and Tunnel Commission

of the recognition accorded the Engineering Profession in this enterprise, so significant in its technical phases and in its economic and social aspects.

John F. Stevens, President, American Society of Civil Engineers — George T. Seabury, Secretary
Julian Kennedy, President, American Institute of Mining and Metallurgical Engineers — H. Foster Bain, Secretary
Calvin W. Rice, Secretary, American Society of Mechanical Engineers
Edward Caldwell, President, American Institute of Electrical Engineers — [illegible], Secretary

Heating and Ventilating Men Foresee Eventful New York Convention

New Departure in Session on Factory Heating and Air Conditioning—Discussion of Low Pressure Boiler Code and Testing Building Insulation—Inspection Tours Slated

A PROGRAM that bids fair to overshadow the interest of former years in the annual meeting of the American Society of Heating and Ventilating Engineers has been drawn up for the coming convention in New York City, Jan. 23-27.

Eleven papers and reports of particular importance for engineers in the field are devoted to boiler problems, pipe sizes, corrosion, surface radiation, air conditioning and relative matters. All technical sessions will take place at the Hotel Pennsylvania, the council meeting opening Monday morning at 10:30 and followed by the committees on research, nomination and other society considerations.

President Paul F. Anderson will deliver his message of welcome in the afternoon, and report will be made by the tellers of election. F. D. Mensing will review the work of the technical advisory committee on radiation. Dr. C. W. Brabbee will speak on the "Testing of Boilers and Radiators." A paper on "Test Methods for Radiators," by F. C. Houghten and S. R. Lewis, will be discussed by Prof. E. H. Lockwood. Early in the evening the Past Presidents' Dinner will be served. The day's business will close with committee reports on research, and an address on that subject by a speaker to be announced later, and F. C. Houghten's research laboratory report.

Aeration of Industrial Buildings

Tuesday afternoon will be given over to a factory heating and ventilating session, initiated by the secretary report of A. V. Hutchinson. Outstanding papers will include "What Will the Engineer Choose—Heating Only or Air Conditioning for the Modern Plant," by H. P. Gant, and "Aëration of Industrial Buildings," by W. C. Randall. The annual dinner and dance are scheduled for the evening.

Five papers of special moment will occupy the Wednesday morning session. In order of presentation they are: "Report of Technical Advisory Committee on Pipe Sizes," by H. M. Hart; "Some Studies of Corrosion in Return Lines of Steam Heating Systems," by F. N. Speller; "Code for Rating Low Pressure Heating Boilers," by Alfred Kellogg; "Relationship Between Output and Operating Characteristics in Tests of Low Pressure Steam Heating Boilers," by P. Nicholls, and "Some Studies Relative to the Rating of Low-Pressure Boilers," by Prof. L. O'Bannon. In the afternoon A. P. Kratz will offer a study on "Standard Test Code for Heat Transmission Through Walls," and Charles S. Sage on "Extended Surface Radiation."

To Inspect Holland Tunnel

"Practical Results of Ventilating the Holland Tunnel," by Ole Singstad, "Report of Technical Advisory Committee on Infiltration," by A. C. Willard, "Saving Heat in Skyscrapers," by F. C. Houghten and M. E. O'Connell, and "Report of Technical Advisory Committee on Temperature, Humidity and Air Motion," by W. H. Carrier, will terminate the technical sessions Thursday morning. Installation of officers will then take place.

Inspection tours are being arranged for those interested in visiting the Holland Tunnel or the Brabbee laboratory in the afternoon. A council meeing will close the convention Jan. 27.

Action to Be Sought on Boulder Dam Bill

Senator Johnson (Rep.), California, who has reintroduced his bill for the construction of the Boulder Canyon Dam, has issued a statement explaining the purposes of the bill and expressing his determination to seek action on the project during the present session of Congress.

The bill authorizing the Boulder Dam project is substantially the bill that was before the last Congress. Both measures are written around the Colorado River Compact in order that the upper-basin states may be thoroughly protected. In the allocation of the waters of the Colorado River, the Federal Government has the undoubted right to direct that the waters stored in any remedial work of the Government shall be utilized in a specific fashion, and the Boulder Dam project contemplates use in accordance with the Colorado River compact.

Commemorates Opening of New San Francisco Club

Commemorating the dedication of the new quarters of the Engineers' Club of San Francisco held the evening of Sept. 30, an illustrated booklet has been published by that Club.

The new home of the members is on the 14th and 15th floors of the recently completed Insurance Center Building at the corner of Pine and Sansome Streets. The dedication address was delivered by Nathan A. Bowers, president of the club. This is reprinted in the booklet, which also shows seven views of the well equipped rooms and appointments.

In recent years the club has become a focal center for activities of engineering societies in the San Francisco Bay region. It is planned to extend this service to the profession and particularly to effect closer relations with national engineering societies.

Duquesne Works to Install Record Feed Water System

A water softening system which will be used for boiler feed, of an ultimate capacity of 8,000,000 gal. a day, will be installed at the Duquesne works of the Carnegie Steel Company. According to announcement, when the capacity is reached, this will be the largest complete water softening and filtration system for the treatment of boiler feed water. It will be installed by Wm. B. Scaife & Sons Company, Oakmont, Pa.

The system will be of the Scaife We-Fu-Go intermittent type wherein the water will be treated and allowed time for reaction and sedimentation in four 540,000-gal. tanks. Each tank will be equipped with mechanical stirring devices for thoroughly mixing the reagents with the raw water to be softened; the tanks will also be equipped with indicating and recording gages for recording the complete cycle of operation of each tank. After the water is softened it will pass through eight concrete filters, each of a capacity of 1,000,000 gal. a day.

The reaction-settling tanks will be equipped with electrically operated valves and the filters will be equipped with oil-pressure-operated valves of the hydraulic type. All filters will be equipped with indicating and recording loss of head gauges and indicating and recording rate of flow controllers.

Pumping Automatically Controlled

The water from the filters will be discharged into a clear well located under the pipe gallery and from which it will be delivered by special pumping equipment to an 800,000 gal. filtered water storage tank. The pumping equipment will be a novel arrangement in that it will be automatically controlled so that the filtered water will be discharged to the filtered water storage tank or to the heaters as may be required without manipulation of valves. A feature of this system will be the fact that all valves are operated by remote control. An operator stationed at the control boards will manipulate all tank and filter valves without having to inspect them personally to see that they have properly opened or closed. This feature will, accordingly, permit operation with fewer men than would otherwise be necessary.

Conowingo Project Nears Completion by Philadelphia Electric Company

Development, One of the Largest in the United States, Soon to Open Operation of Initial Unit—11 Units of 54,000 Hp. the Ultimate Capacity

THE hydro-electric development at Conowingo, Md., on the Susquehanna River, said to surpass Muscle Shoals and to rank second in the United States to that of the Niagara Falls Power Company, is nearing completion by the Philadelphia Electric Company at an estimated total cost of $52,000,000.

When put into operation next year, it will play an important rôle in the recently announced power merger of that company, the Pennsylvania Power & Light Company and the Public Service Electric & Gas Company, of New Jersey. The tie-in among these companies will result in what is held by many to be the largest combination of electrical generating capacities in the world. The Conowingo plant ultimately will make use of the entire normal flow of the Susquehanna River.

In Operation by 1929

Work was started March 8, 1926 and the station will be in active operation before the end of next year. The highway bridge, the relocated highway and the new railroad location will be ready for operation this winter.

A dam 200 ft. longer than that at Muscle Shoals forms a lake approximately a mile wide and extends 14 miles up the river. The area flooded will cover nearly 9000 acres and will contain about 14,000,000,000 cu.ft. of water which will be used to operate 11 generators. The current will be sent over two transmission lines to the switching station, which the Philadelphia Electric Company is now building at Plymouth Meeting, Pa., 70 miles away.

This substation will cover 14 acres and will link plants of the company in Philadelphia with that of Conowingo. The substation also will be connected with similar terminal substations at Siegfried, Pa., near Allentown, and Livingston, N. J., near Newark, so that an interchange of power may be effected.

While the Conowingo plant will ultimately contain 11 generators, each rated at 54,000 hp., the initial installation will include but seven of these units.

According to Walter H. Johnson, president of the Philadelphia Electric Company, the first of these units will be in operation by June of next year. The other six units will be placed in service each month, so that by the end of the year seven units will be in operation.

It is expected that 1,360,000,000 kw.-hr. of energy will be produced by the plant in the average year, 750,000 tons of coal thus being saved.

Across the top of the dam there will be a highway bridge, 105 ft. above the foundation, as a part of the main highway between Philadelphia and Baltimore, replacing one submerged in the reservoir.

Water Level to Be 108½ Feet

On the crest of the spillway, the top of which will be 86 ft. above sea level, will be 50 movable steel gates, 22½ ft. high and 40 ft. wide. These gates will maintain the water level behind the dam at 108½ ft. above sea level.

The power house itself will be 175 ft. wide and 621 ft. long, with an ultimate length of 900 ft. From the bottom of the draft tubes to the top of the high-tension switching station on the roof it will be 230 ft. The bottom of the draft tubes will be 25 ft. below sea level.

The Susquehanna watershed of 27,000 sq. miles includes a large part of the central section of Pennsylvania, considerable of southern New York State and a bit of northern Maryland. The average river flow is 40,000 cu.ft. a second.

Alternatives Made Clear for Coal Industry's Future

Stability in the soft coal industry must come in one of two ways, operators and miners meeting here under the chairmanship of James J. Davis, Secretary of Labor, to find a way out of the present strike, have decided.

Either present wasteful practices will continue until the survival of the most powerful companies forces the others to the wall at some remote time, or Congress, which alone has the power, heeds President Coolidge's proposal, twice made, for establishment of an arbitration commission or board, to act in emergencies when the nation's supply of coal is threatened.

This was the statement given out by Mr. Davis, in which he summarized the fundamental points on which both parties agree. He reported progress in negotiations between mine owners and unions, which have named joint committees of three to meet for discussions. Negotiations are handicapped somewhat by the absence of the largest soft coal operators, who refused to attend the conference.

Sees No Shortage

Mr. Davis said there is no shortage of coal, and production goes on at ample rate. The industry is overdeveloped and too many mines are already operating—a great majority of them, union and non-union, are working only part time.

More than 100,000 men are on strike, many companies are insolvent, and the wages of men actually employed are often far below the American standard—yet new mines are constantly opened, he said.

"It is conceded by both operators and miners that as a result of this overdevelopment the root evil of the industry is cut-throat competition." According to Mr. Davis, it is complained the railroads take undue advantage of the coal operators' frequent necessity to sell below cost of production.

The roads buy 28 per cent of the entire output, he said, and naturally seek lowest prices. Operators bid against each other for this bulk trade, often at a loss.

Outside Help Needed

After further discussion of the industry's adverse condition, Mr. Davis said that both operations and miners concede "that the industry's chances of solving its own problem are none too favorable."

Either the industry is to be left to sink of its own weight, Mr. Davis said, with the stronger elements absorbing the weaker and stabilization at length obtained at unnecessary cost and with further hardship to labor, or Congress, which alone has power to act, may heed the plan which President Coolidge has twice offered.

Coal representatives pointed out that as emergency is chronic in this industry, supervision might have to be given to a body similar to the Interstate Commerce Commission.

Largest High-Pressure Boiler Plant for England

Plans for the immediate construction of what is reported will be the largest high-pressure boiler plant in the world, installed at the works of the Synthetic Ammonia & Nitrates Company, Ltd., at Billingham-on-Tees, England, were announced by George E. Learnard, president of the International Combustion Engineering Corporation, Dec. 14, on receipt of a cable message from the British subsidiary.

International Combustion, Ltd., will build all the equipment going into this plant, including high-pressure steam generating units, of which there will be six of 800 lb. pressure, with a generating capacity of 269,000 lb. each.

The plant is designed to burn pulverized coal, and International Combustion's Lopulco Systems for the preparation and burning of the coal has been ordered together with that company's complete steel furnaces, many of which for the last year have been installed in modern plants on both sides of the Atlantic.

"When it is considered that the steam generating and combustion equipment only, and exclusive of all other construction work and equipment, will total upward of $2,500,000 the magnitude of the undertaking is apparent."

Finds No Recent Oil Price Fixing, Commission Says

The Federal Trade Commission, in a report submitted to Congress Dec. 12 on "Prices, Profits and Competition in the Petroleum Industry," states that it finds no recent evidence of agreements or manipulations of any size among large oil companies to raise or depress prices of crude petroleum or refined products.

It will report, however, that in 1926 and 1927 officials of the largest oil companies agreed to restrict production of crude petroleum in the Seminole fields for protection of their profits through prevention of further decline in crude and refined prices, and for prevention of waste, in which activity they were aided by public authorities of Oklahoma.

Output to Conserve Supply and Protect Interests

A growing sentiment was noted by the commission for regulating production of petroleum so as to conserve the supply and protect the financial interests of land owners and operating companies. The commission was not prepared to recommend particular methods to be used, as that problem is now being considered by the Federal Oil Conservation Board.

A resolution of the Senate adopted in June, 1926, directed this inquiry, with special instructions to investigate as to whether there was arbitrary control of prices of petroleum and its products through agreements or through conditions of ownership or control of oil properties.

Prices, according to the report, materially advanced in the face of rapidly accumulating stocks early in 1924, 1925 and 1926 and were reduced later in those years when stocks were decreased.

Early in 1927 the change in prices was downward, in strong contrast to what happened in the three years preceding.

Memory of All Engineers in War to Be Honored

The committee of the four engineering societies on the War Memorial to American engineers has just announced that the clock and the carillon for the tower of the new Louvain Library will be made a memorial to all engineers of the United States who gave their lives in service of their country or its allies at home or overseas or on the seas, in any branch of service in the great war from 1914 to 1918 and not exclusively to such members of the societies as was originally planned. The committee seeks information of all such men so that their names may be suitably recorded in this honor roll.

The committee further announces that on the advice of its carillon architect, Frederick C. Mayer, who is also organist of the West Point Military Academy, the compass of the Louvain carillon has been increased from three to four octaves. It will thus have forty-eight bells and be at least the equal of the famous old carillon at Malines, Belgium, which for many years has been the finest in Europe—indeed the finest anywhere in the Eastern Hemisphere, the standard of carillon excellence.

A.S.M.E. Spring Meeting at Pittsburgh, May 14-17

With the annual winter meeting of the A.S.M.E. over, interest is turning to the society's plans for the convention in the spring.

Pittsburgh has been chosen as the city for the gathering to be held from Monday, May 14 to 17, inclusive, and the plans laid thus far promise an all-round excellent convention with a well balanced program of technical sessions, inspection tours and entertainment.

As is customary, Monday morning will be given over to registration and the meeting of the Council. The afternoon will be devoted to a continuation of the Council Meeting with simultaneous sessions on fuels, education and training, and management.

Tuesday there will be sessions on iron and steel, hydraulics, railroads, and glass with an excursion to Clairton in the afternoon.

Industrial power, machine-shop practice, petroleum and applied mechanics will feature Wednesday meetings with excursions in the afternoon to any of Pittsburgh's many steel plants, all of which will be open to inspection of the A.S.M.E. members and their friends attending the meeting.

Friday will close the meeting with sessions of materials handling, central-station power, alloys and applied mechanics.

Entertainment is being planned for both Monday and Wednesday evenings.

Utah Fact-Finding Commission Studies Colorado Power

Three reports containing conclusions and recommendations have already been issued by the Colorado River Fact-Finding Committee organized by the Utah Associated Industries and the Utah State Farm Bureau, of which committee James J. Burke, a Salt Lake City engineer, is chairman. The first report outlines a preliminary course of procedure; the second deals with protection to the Imperial Valley from floods, pointing out that this is an international question involving Mexico, and the third is concerned with water supply and power.

The committee doubts whether Colorado River power could compete in cost with power generated from steam in southern California at the present time, without giving any consideration to decreasing cost of steam-generated power. "The committee failed to find any condition or hopeful signs that seemed to justify or warrant any corporation, public or private, to hazard a long-time contract for this proposed new power."

Films of Mining and Manufacturing are Ready to Lend

Motion picture films showing mining and manufacturing processes are now ready to be borrowed directly from the Bureau of Mines Experiment Station, Pittsburgh, Pa., under the direction of R. A. Wood, supervising engineer. M. F. Leopold, safety engineer, supervised their production.

Those films which may be of interest to *Power* readers include: Nos. 60. Story of Coal (3), National Coal Association; 74. Story of Asbestos (4), Johns-Manville Company; 76. Story of Abrasives (4), Carborundum Company of America; 84. Story of an Electric Meter (3), Sangamo Electric Company; 88. Water Power (2), Westinghouse Electric & Manufacturing Company; 91. Story of Steel (6), United States Steel Corporation; 93. Story of Alloy Steel (4), Interstate Iron & Steel Company; 97. Story of Fire Clay Refractories (4), Laclede-Christy Clay Products Company; 102. Story of Heat Treatment of Steel (2), Hupp Motor Car Corporation; 111. Story of Power (3), Stone & Webster, Inc.; 120. Story of Lubricating Oil (2) and Story of Lubrication (1), Standard Oil Company Indiana; 131. Story of Petroleum (6), American Petroleum Institute, and 132. The Story of Iron (4), Bethlehem Steel Corporation, Youngstown Sheet & Tube Company, and Pickands, Mather & Company.

The organizations named above have for loan copies indicated by the bureau list number. If the film cannot be obtained from the companies request should be made to the Bureau of Mines Experiment Station, Pittsburgh, Pa.

Obituary

F. J. Fyfe, salesman in the circulation department of the McGraw-Hill Publishing Company for 25 years, and known to nearly every operating engineer in New Jersey, died Dec. 14 following several months of heart trouble. Mr. Fyfe was 61. In 1902 he started as salesman for the subscription department of *Power*, and handled the state of New Jersey during that period until his retirement from active work last summer. Mr. Fyfe took an active interest in the N.A.S.E., and his enthusiastic support won for him popularity in the local chapters of New Jersey and New York.

Personal Mention

J. S. DALES has been elected vice-president of the Public Utilities Consolidated Corporation, the utility holding company for the W. B. Foshay Company.

JAMES E. DAVIDSON, vice-president and general manager of the Nebraska Power Company, was elected president of the Greater Omaha association at its annual meeting.

H. B. ADDINGTON, member of the A.S.M.E., has resigned his position as chief engineer of the heating division of the Modine Manufacturing Company, Racine, Wis., to return to Cleveland about Jan. 1. Mr. Addington was previously with Clark, MacMullen & Riley, Cleveland.

MISS KATE GLEASON, member of the A.S.M.E., is now in France at her chateau, near Septmonts, on the Aisne. She is reconditioning an old wine ship in the neighborhood and turning it into a library as a memorial to the 1st Division of the A.E.F., which sustained heavy losses in a four-day battle in that war sector.

FRANKLIN J. HOWES, formerly consulting engineer for the Rochester (N. Y.) Gas & Electric Company, assumed his new duties as public utility expert for the Prudential Insurance Company, Newark, N. J., on Dec. 1. Mr. Howes was given a testimonial dinner by many of his friends and associates at the Rochester Club, Nov. 26.

W. MILLER SHAW, formerly vice-president and general manager of the Benjamin F. Shaw Company, and HARRY M. PIERCE, who was for many years chief engineer of the Du Pont Engineering Company, have recently acquired control of the Benjamin F. Shaw Company, steam fitters and engineers, Wilmington, Del.

HARLOWE HARDINGE, vice-president and general manager of the Hardinge Company, York, Pa., sailed for Europe on the "Berengaria" Dec. 14. Mr. Hardinge will be away on business for from four to six weeks. On the same date, H. W. HARDINGE, president, and Mrs. Hardinge sailed for an extended pleasure trip through Europe and the East.

E. C. DEAL, was recently elected president of the People's Light & Power Corporation.

CHARLES G. ADSIT, vice-president and consulting engineer of the Georgia Power Company, Atlanta, has resigned to engage in private consulting engineering work with offices in Atlanta.

SYLVAN J. CROOKER, has been elected vice-president in charge of engineering for the Heat Transfer Products, Inc., recently organized by the Staten Island Shipbuilding Company, Staten Island, N. Y. Mr. Crooker did not serve as chief engineer for the Whitlock Coil Pipe Company as recently reported in *Power*, according to a statement received from the Whitlock Coil Pipe Company.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

E. G. BAILEY, president of the Fuller-Lehigh Company, Fullerton, Pa., recently lectured on the development of equipment for utilization of powdered fuel before the students of the University of Pennsylvania's new course in fuel engineering.

CHARLES W. AMIDON, who has been vice-president and general manager of the Central Power Company, Grand Island, Neb., for the past year and one-half, has been elected president of that utility. Previous to transferring his interests to Nebraska in 1926 Mr. Amidon spent twelve years with the Central Illinois Public Service Company.

J. W. WHITE was recently elected a director and managing director of the Westinghouse Electric Company of Japan. Mr. White enters his new work from a wide background of experience with the Westinghouse Company, both in the United States and abroad, having been respectively general manager of the Japan company, manager of the power section of the Detroit office, and manager of the Westinghouse International Company of Cuba.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except **Pittsburgh gas slack:**

Bituminous (Net Tons)	Market Quoting	
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.39
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.50@ 1.75
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.00@ 1.15
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.00@ 2.35
West Ky.	Louisville	1.00@ 1.50
S. E. Ky.	Louisville	1.25@ 1.75
Big Seam	Birmingham	1.65@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	2.75@ 3.25
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.50@ 1.60

FUEL OIL

New York—Dec. 15, light oil, tank-car lots, 26 deg. Baumé, 5c. per gal.; 28 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 30, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5.3c. per gal.

Pittsburgh—Nov. 28, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia—Dec. 15, 26@30 deg., $1.60@$1.66 per bbl.; 13@19 deg., $1.47 @$1.53 per bbl.; 22 plus, $1.63@$1.69 per bbl.; 27@30, $2.10@$2.16 per bbl.

Cincinnati—Dec. 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Dec. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Dec. 12, tank-car lots, f.o.b., 12@14 deg. Baumé, 4.22c. per gal.; 28@32 deg., 5¾c. per gal.

Dallas—Dec. 10, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Society Affairs

A. S. M. E. BUFFALO: January 17, Hotel Statler at 8:00 p.m. Subject: "The Arteries of Industry," motion picture films, National Tube Co. W. P. Wooldridge will lecture. There will also be shown a film on building New York's newest subway by the Dupont Company.

Business Notes

THE LINCOLN ELECTRIC COMPANY, Cleveland, announces the transfer of E. F. Hoff from the welder division at Cleveland to the welder division at New York, where he will be in charge of welder service under the direction of G. N. Bull, district manager.

THE BOILER ENGINEERING COMPANY, 931 Federal Trust Building, Newark, N. J., now owns and controls the Turner boiler baffle wall which was originated by T. G. Turner about thirteen years ago, who, with J. W. Putnam, oraganized the Baffle Wall Repair Company.

Trade Catalogs

OIL BURNERS AND PREHEATERS—The Alexander Milburn Company, Baltimore, devotes illustrated Bulletin B-200D to the description Milburn oil burners and preheaters for welding, boiler, machine and repair shops.

ACETYLENE GENERATORS for use with Oxyacetylene welding and cutting apparatus are described by the Milburn Company, Baltimore, in Bulletin B-200C, which depicts 200-300 lb. standard types and type C. Specifications are also given.

RECORDING INSTRUMENTS IN POWER PLANT—The Bristol Company, Waterbury, Conn., has issued a new bulletin No. 362, on the subject of Bristol's recording instruments in the power plant. This contains considerable valuable information for the specifying of such equipment.

METERED COMBUSTION CONTROL as used at the Manchester Street Station of the United Electric Railways Company, Providence, R. I., is described in a paper by A. S. Davis, superintendent which has been reprinted and is being distributed by the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia. The rate of combustion is regulated according to the steam demand by a master controller connected to the steam header so that it responds to drop in pressure due to flow of steam and sets up an electrical control current proportional thereto. This current cooperates with control devices that actually meter the pulverized coal and the air supplied to burn it, to hold the two in a definite ratio and in proper amount to meet the steam demand. Charts from recording instruments show a constant percentage of excess air and a uniform steam pressure, in spite of a rapidly fluctuating steam flow incidental to load swings in a traction plant. The percentage of CO_2 is set to be maintained as high as is compatible with economical operation of the furnaces, taking into consideration maintenance, combustible in ash and combustible loss.

BAFFLES—The Engineer Company of New York announces a new catalog on Enco baffle walls and the Enco cross baffle. The book describes new and improved baffle construction with horizontal and vertical boilers.

The company announces in the catalog that it has discarded and will no the company has discarded and will no longer furnish baffles made under the Turner patent. The catalog will be sent upon request.

NEW PLANT CONSTRUCTION

Ariz., Phoenix—Security Investment Co., awarded contract for an 8 story office building on Phoenix St. here to Edwards, Wildey & Dixon, Edwards & Wildey Bldg., Los Angeles, Calif. Estimated cost $600,000. Steam heating system, elevators, etc. will be installed.

Calif., Fresno—Pacific Fruit Express Co., 65 Market St., San Francisco, is receiving bids for an ice plant here. Estimated cost $500,000. Private plans.

Calif., Long Beach—City will receive bids about Jan. 9 for the construction of two pumping stations, etc. for sewage treatment works. Estimated cost $750,000.

Calif., Oakland — H. C. Capwell Co., awarded contract for a 10 story department store at 20th St. and Broadway, to P. J. Walker Co., Sharon Bldg., San Francisco. Estimated cost $3,000,000.

Calif., Stockton — Thomas Canning Co., Filbert and Miner Ave., awarded contract for the construction of a plant including 25 x 30 ft. power house to Michel & Pfeffer, 10th and Harrison Sts., San Francisco.

Calif., Tracy—City plans waterworks improvements including new well, 300,000 gal. reservoir, etc. E. T. Bartlett, American Bank Bldg., is engineer.

Conn., Greenwich — Connecticut Light & Power Co., 274 Greenwich Ave., awarded contract for the construction of an electric service building on Field Point Rd. to U. G. I. Construction Co., c/o owner. Estimated cost $250,000.

Del., Bethany Beach—U. S. Property & Disbursing Officer, Washington, D. C., will soon award contract for the construction of a group of buildings including power house, etc. here.

Ga., Atlanta—Chevrolet Motor Co., General Motors Bldg., Detroit, Mich., awarded contract for an automobile assembly plant including detached power plant on Sawtell Rd. to Fred T. Ley Co., Consolidated Bldg., Jacksonville, Fla.

Ill., Chicago—Lawrence Building Corp., 4615 Broadway, will soon award contract for a 12 story apartment and stores building including elevators, etc. at Lawrence and Kenmore Aves. Estimated cost $2,300,000. Huszagh & Hill, 6 North Michigan Ave., Archts.

Ill., Chicago — Lowenberg & Lowenberg, 111 West Monroe St., Archts., will soon receive bids for a 12 story hotel at North Clark St. Lincoln Ave. and Wells St., for Syndicate, c/o M. E. Feiwell, 11 South La Salle St. Estimated cost $1,000,000.

Ill., Chicago—Medinah Athletic Club, 11 South La Salle St., awarded contract for a 44 story club building including central refrigeration plant at Michigan Ave. and Illinois St. to Paschen Bros., 111 West Washington St. Estimated cost $5,000,000. Elevators, etc. will be installed.

Ill., Chicago—Schmidt, Garden & Erickson, 104 South Michigan Ave., Archts., are receiving bids for a 16 story office and stores building at 16-30 West Washington St. for syndicate. Estimated cost $2,300,000.

Ind., Indianapolis — Indianapolis Water Co., 113 Monument Circle, awarded contract for the construction of a boiler room and pumping station at Speedway Rd. and Belt Ry. to Hall Construction Co., 406 Bd. of Trade Bldg. Estimated cost $40,000.

Ia., Des Moines — Northwestern Bell Telephone Co., 1906 Douglas St., Omaha, Neb., will receive bids about Jan. 1, for a 9 story office building, here. Estimated cost $800,000. G. B. Prinz, 1037 Omaha National Bank Bldg., Omaha, and Rawson & Souers, 810 Hubbell Bldg., Des Moines, are associate architects.

Kan., Manhattan—Kansas State Agricultural College, will receive bids until Dec. 21 (extended date) for the construction of a power house. Estimated cost $325,000.

La., Lake Charles—Gulf States Utilities Co., awarded contract for addition to ice plant, to P. O. Oliver & Son. Estimated cost $80,000.

Md., Baltimore—Title Guaranty & Trust Co., St. Paul and Lexington Sts., awarded contract for a 12 story hotel at Eager and St. Paul Sts. to M. A. Long Co., 10 West Chease St. Estimated cost $800,000. Steam heating system, etc., will be installed.

Mass., Boston—Building Dept., plans the construction of a power house and heating plant. Estimated cost $100,000.

Mass., Cambridge (Boston P. O.)—Cambridge Hospital, W. F. Earle, Chn. Executive Committee, is having plans prepared for a hospital, nurses home, etc. on Mt. Auburn St. Estimated cost $650,000. Kendall, Taylor & Co., 142 Berkley St., Boston, are architects.

Mich., Benton Harbor — Syndicate, c/o Cobb & Eisenberg, 5 North La Salle St., Chicago, Ill., is having plans prepared for a 4 story hotel, etc. including swimming pool at Parker Station, 8 mi. from here. Estimated cost $500,000.

Mich., Alpena—Alpena Power Co., is having plans prepared for an earth fill dam 200 ft. long on South Branch River. Estimated cost $25,000. Private plans.

Mich., Detroit—Chrysler Motor Corp., 12265 East Jefferson Ave., awarded contract for addition to automobile factory including detached power plant on Kercheval Ave. to C. O. Barton, 508 Free Press Bldg. Estimated cost $65,000.

Mich., Grand Rapids—Consumers Ice Co., Market St., awarded contract for the construction of an ice plant to Jacob Perkins & Sons, Perkins Bldg. Estimated cost $50,000.

Mo., Lockwood—City plans an election soon to vote $50,000 for waterworks improvements including deep well, pumping equipment, mains, etc. Alexander Engineering Co., Woodruff Bldg., Springfield, is engineer.

Mo., St. Louis—G. W. Hunter, c/o Midland Real Estate Co., 8 North Eighth St., is having preliminary plans prepared for a 12 story hotel including steam heating system, etc. at Eighth and Market Sts. Estimated cost $1,000,000.

Neb., Fairbury—City is having preliminary plans prepared for rehabilitation of water and light plant. Estimated cost $135,000. Burns & McDonnell Engineering Co., 401 Interstate Bldg., Kansas City, Mo., are engineers.

N. J., Deep Water Point (mail Penns Grove)—American Gas & Electric Co. and American Electric Power Corp., 30 Church St. New York, N. Y., awarded contract for design and construction of a steam power plant including two 50,000 kw. units on the Delaware River here to Stevens & Wood, 120 Broadway, New York, N. Y. Total estimated cost approximately $20,000,000.

N. J., Somerville—S. C. and M. Platt, 220 West 43rd St., New York, N. Y., is having plans prepared for a hotel including steam heating system, boilers, etc. here. Estimated cost $1,000,000.

N. Y., Cheektowaga (mail Depew)—Dept. of Parks & Public Buildings, J. P. Moore, Comr., Buffalo, will soon award contract for the construction of a boiler plant, etc. at Buffalo Airport, Genesse St. and Cayuga Rd. here.

N. Y., New York—Corporation, c/o Bernard Noonan, 79 West 162nd St., is receiving bids for a 6 story apartment building at Woodycrest Ave. and Macombs Dam. Estimated cost $1,000,000. H. Ginsberg, 220 East 42nd St., is architect. Work will be done by separate contracts.

N. Y., New York — Eight Hundred Fifty Six Fifth Ave. Corp., c/o M. E. Paterno, 200 West 72nd St., will build a 12 story co-operative apartment building. Estimated cost $800,000. R. Candala, 578 Madison Ave. and Warren & Wetmore, 16 East 47th St., are associate architects. Work will be done by separate contracts.

N. Y., New York—Isaac Polstein & Son, 285 Madison Ave., is having plans prepared for a 15 story apartment at 91st St. and Riverside Dr. Estimated cost $1,000,000. E. Roth, 1440 Broadway, is architect. Owner is general contractor.

N. Y., New York — Walter Russell, 1 West 67th St., is having sketches made for a 14 story studio building at 160 West 73rd St. Estimated cost $1,200,000. Architect not announced.

N. Y., New York—Sixty Gramercy Park North, Inc., J. R. Barr, Pres., 347 Madison Ave., will receive bids about Jan. 1 for two 16 story apartment buildings at 105-109 East 21st St., to 112-120 East 22nd St. Estimated cost $2,500,000. E. Roth, 1440 Broadway, is architect.

N. C., Jackson Springs—Jackson Springs & Bad Neuheim Corp., plans the construction of a hotel, etc. Estimated cost $1,250,000. George Post & Son, 101 Park Ave., New York, N. Y., are architects.

O., Cincinnati — The Fox Film Co., 850 10th Ave., New York, N. Y., plans the construction of a 6 story theatre and office building on Main St. Estimated cost $1,000,000. W. W. Ahlschlager, 65 East Huron St., Chicago, Ill., is architect.

O., Cincinnati — Ohio Building & Construction Co., 2513 Burnet Ave., plans the construction of a 10 story apartment building at Victory Parkway. Estimated cost $1,500,000.

O., Cleveland—The Cleveland Electric Illuminating Co., R. Lindsey, Pres. and Gen. Mgr., Illuminating Bldg., is receiving bids for an electric-sub-station on West 95th St. Estimated cost $200,000. Private plans.

O., Dayton — Good Samaritan Hospital Assn., M. J. Gibbons, Jr., 22 Oxford Ave., Chn. of Committee, plans the construction of a hospital at Fairview and Salem Sts. Estimated cost $1,000,000. Architect not selected.

O., Mount Washington — St. Gregorys' Seminary, will soon award contract for a 4 story school at Ohio Park. Estimated cost $1,500,000. Maginnis & Walsh, 100 Boylston St., Boston, Mass., are architects.

Okla., Clinton—City plans an election Dec. 19 to vote $60,000 bonds for waterworks improvements including impounding reservoir, dam, filter plant, pumping equipment, etc. Benham Engineering Co., 512 Gumbel Bldg., Kansas City, Mo., is engineer.

Pa., Philadelphia—Quaker City Cold Storage Co., Water and Spruce Sts., will soon award contract for the construction of a cold storage plant at 314 South Delaware Ave. Ballinger Co., 12th and Chestnut Sts., is architect.

Tex., Galveston—W. L. Moody, Jr. & Associates, are having plans prepared for an 11 story hotel including cooling water system, etc at Tremont St. and Boulevard. Estimated cost $1,000,000. A. Frezier, American National Insurance Bldg., is architect.

Tex., San Angelo—Concho Realty Co., is having plans prepared for a 12 story hotel, also a 12 story bank and office building at West Twohig Ave. between Irving and Randolph Sts. Estimated total cost $1,300,000. Kohn & Morgan, are architects.

Tex., San Antonio—R. W. Alford, 102 West Craig Pl., awarded contract for the construction of an ice plant on Garden and Gembler Sts. to Granberg & Balzen, 1127 South Hackberry St. Estimated cost $25,000.

Wash., Seattle—Bd. of Public Works, received lowest bid from Allis Chalmers Mfg. Co., 115 Jackson St., for electrical machinery including 14,285 kva. generator with reaction type turbine, transformers, switches, exciter, etc. for unit No. 6 of Cedar Falls hydro-electric power project. $155,374.

Ont., Hamilton — McMaster University Board, 273 Bloor St., W., Toronto, is having plans prepared for the construction of a group of college buildings including steam heating system, etc. here. Estimated cost $1,500,000. W. L. Somerville, 2 Bloor St. W., Toronto, is architect.

Ont., Toronto—The Star Publishing Co., 18 King St. W., will soon receive bids on superstructure of a 20 story newspaper office and plant. Estimated cost $3,000,000. Chapman & Oxley, Northern Ontario Bldg., are architects.

Ont., Toronto — Yolles & Rotenberg, Federal Bldg., will build a 20 story office building including steam heating system, elevators, etc. at Bay & Richmond Sts. Estimated cost $1,000,000. Chapman & Oxley, Northern Ontario Bldg., are architects. Work will be done by day labor.

T. H., Pearl Harbor—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a refrigeration plant at Naval Operating Base (Submarine Base) here.

Equipment Wanted

Boiler, Motors, Etc.—Quinlan, Robertson & Janin, 702 Sherbrooke St. W., Montreal, Que., is in the market for one 50 hp. steam boiler, four 100 hp. electric motors, etc.

Boilers—City Water Board, c/o R. W. Masterson, Supt., San Antonio, Tex., will receive bids until Dec. 21 for two 300 hp. vertical and semi-vertical water tube boilers for Water Dept.

Boilers and Motors—New Carlton Hotel, 913 Windsor St., Montreal, Que., is in the market for two 10 hp. steam boilers and two 18 hp. electric motors.

Boilers and Turbines — Waldorf Paper Products Co., Myrtle and Pillsbury Aves., St. Paul, Minn., plans the installation of complete equipment including boilers and steam turbines.

Conveyors — West Michigan Core Sand Co., Muskegon, Mich., plans to purchase conveyors for loading sand for proposed pier. Estimated cost $150,000.

Electrical Equipment—Escondido Mutual Water Co., Escondido, Calif., plans to purchase electrical equipment for 350 kw. unit.

Engine, Pumping Equipment — Bd. of Water Comrs., M. E. Wilson, Secy., Hammonton, N. J., will receive bids until Dec. 23 for furnishing and installing a 90 hp. Diesel engine and pumping equipment in artesian well.

Motors—Dept. of Public Works, Room 406, City Hall, Chicago, Ill., will receive bids until Dec. 22 for four 40 m.g.p.d. motor driven centrifugal pumps also four 1,200 hp., 600 r.p.m. electric motors complete with starting equipment for Water Pumping Station, Eastwood Ave.

Pumping Unit — City of Lindale, Tex., plans to purchase a pumping unit for proposed waterworks and distribution systems. Estimated cost $55,000.

Pumping Unit — Delta Development Co., E. C. Couch, Weslaco, Tex., will soon receive bids for a pumping unit for proposed waterworks and distribution systems at Brownsville, Tex. Estimated cost $30,000.

Pumps—Sewerage & Water Board, G. G. Earl, Gen. Supt., New Orleans, La., will receive bids until Jan. 23 for pumps for River Pumping Station.

Pumps—U. S. Veterans' Bureau, Room 791, Arlington Bldg., Washington, D. C., will receive bids until Jan. 3 for three deep well pumps in U. S. Veterans' Hospital, Bedford, Mass.

Pumps and Motors — The Washington Pulp & Paper Co., Port Townsend, Wash., plans to purchase 80 electric motors from 300 hp. down and an equal number of from 12 in. down to be installed in the pulp and paper plants now under construction at Port Townsend, and Hoquiam, Wash., to cost $80,000.

Pumps, Oil Purifier, Transformers, Etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Feb. 23 for motor driven horizontal and vertical centrifugal pumps, one motor driven rotary pump, one centrifugal oil purifier, transformers, etc. for proposed Diesel oil purification plant at Pearl Harbor, T. H.

Refrigeration Equipment — Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans to purchase refrigeration equipment for Navy Yard, Mare Island, Calif.

Refrigerator Equipment—Chapmans Ltd., 330 Gerrard St. E., Toronto, Ont., plans to purchase refrigerator equipment.

Water Heater — City of Cleveland, O., will receive bids until Dec. 23 for a deaerating feed water heater for City Hospital. Hospital.

POWER *Information Bureau*

Your machinery, equipment, and materials requirements will be noted *free of charge* in the New Plant Construction section of POWER.

Use the Coupon to make your requirements known

A. W. WELCH
Power Equipment Information Bureau
Tenth Ave. at 36th St., New York, N. Y

In the market for.....

Name .....

Company or Plant.....

Address .....